ECONOMIC ASPECTS OF THE 'KYET-MAUK-TAUNG' IRRIGATION PROJECT IN CENTRAL BURMA

by

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D E C L A R A T I O N

Except where otherwise indicated, this thesis is my own work.

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ABSTRACT

During the early 1960s the Government of Burma was actively developing a number of major irrigation works which included our present study. The project region lies in the arid zone of Central Burma which is widely known as the Dry Zone Area because of its scarcity of water and high temperate climate. Therefore, a small local community living there found it extremely difficult to raise agricultural crops. Furthermore, the only means of livelihood available was to produce jaggery. This provided low incomes and was also causing deforestation in the area. These factors have led to the development of this dam which later came to be known as 'Kyet-mauk-taung'.

The project was jointly built by local engineers along with the Soviet experts. The construction of the project started in the year 1961-62 and was finally completed in 1967-68. The project is located just above the conjunction of the two rivers namely 'Kyaukpon' and 'Taungzin' which have 52.24 square miles and 86.74 square miles of catchment area respectively. The dam was constructed at a suitable location, both feasible and sound from geological and engineering points of view. It is a rolled earth-filled dam with a maximum height of 112.5 feet at the deepest section and a total length of 8,500 feet.

The main construction work was the erection of an earthen dam. Other major works include the construction of a reservoir outlet, an escape, and a network of distribution canals which is divided into the Left and the Righ main canals. The storage reservoir has a water spread area of about 1,800 acres and a maximum depth of 97 feet. It is also designed to have a full tank capacity of 73,100 acre feet allowing 3,100 acre feet of dead storage and enough to supply water to an irrigated tract of 50,000 acres.

The total construction period took almost seven years though it was planned to be fully constructed within a period of five years. The entire cost of the project was initially estimated to be 41.97 million Kyats but with additional costs on construction materials and equipment, the actual costs amounted to 57.08 million Kyats. The Governments of Burma and the Soviet Union agreed upon a credit of 3.5 million roubles bearing an interest of 2.5 per cent per annum to make necessary payments for designs and surveying works and also for the purchase of equipment and materials needed for the project. This constituted 35 per cent of

the total cost.

In accordance with the protocol signed between the two governments, the Burmese Government paid equal annual instalments of principal repayments amounting to 291,056 roubles each year from 1968 to 1979. In terms of local currency the total repayments accounted for 24.6 million Kyats and total interest charges for 3.6 million Kyats.

Under the current agricultural programme, the total cultivable area including double cropping areas is targeted at 48,283 acres. Throughout the agricultural years from 1968-69 to 1970-80, only in two years, i.e. the years 1969-70 and 1970-71, was the planned target achieved. On the other hand, annual water inflow into the storage reservoir was also dissatisfactory against the designed run-off, which was mainly due to low rainfalls in the upper catchments of the basin. Cotton growing is the most important in the command area. Other major crops include rice, groundnut and sesamum which are grown twice a year in the irrigated tract. Cotton and sesamum both accounted for over 75 per cent of the irrigated land and nearly 70 per cent of the total value of crop production.

In the social benefit-cost analysis of the project there are three market values to be adjusted, namely, (a) the foreign exchange component in the construction cost; (b) unskilled labour; and (c) the value of crop production.

The foreign exchange component is assumed to have a worth more than its official exchange rate. This is mainly because of the subsidised prices on the imported machinery and equipment during the construction period. Therefore, for the adjustment of market prices, a foreign exchange premium of 25 per cent is attached to these values.

The valuation of total crop production attributable to irrigation water is done with market prices or administered prices fixed by the government. However, it is assumed that these administered prices fail to reflect the true consumers' willingness to pay. This is mainly because of the existence of the illegal black market for agricultural products. Therefore, there is a need for an adjustment of these prices. Here, a shadow price multiplier of 1.6 higher than that of market prices is used in the social valuation of total crop production.

There are three social rates of discount used in our social benefit cost analysis which are 3 per cent, 6 per cent, and 8 per cent. The reason is that these are, in fact the official bank rates during the early 1960s and 1970s which are believed to reflect the social preferences of the country.

There was little or no existence of agriculture prior to the project. Therefore, total agricultural production attributable to irrigation water is actually the total agricultural benefits to the region. On the other hand, it is also important to note that the effects of water to this water-scarce area have resulted in a substantial reduction of water-borne diseases. In the benefit-cost analysis, the project, though it was not financially sound, was found to be economically sound from the national standpoint. The project, in fact, was designed to open up a poor region.

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CHAPTER 1

INTRODUCTION

Many people regard irrigation as absolutely essential for agricultural development of regions with low or uncertain precipitation rates. With this in view, many underdeveloped countries have embarked on a series of large irrigation projects. In real practice, these irrigation projects have not been as beneficial as was anticipated. It is imperative that we should reassess the benefits of irrigation to agricultural development. This is borne out by experience in many countries, that most projects yield less than expected but not so much due to lack of economic evaluation, but to inadequacies in the basic feasibility studies, especially with regard to the agricultural aspects of irrigation.

It would appear that feasibility studies of these large irrigation projects frequently tend to overlook the fact that an irrigation project involves more than the construction of a dam and a distribution system. Essential for its success is the use to be made of the water thus provided, and the increase in agricultural output in which it results.

The present study evaluates the experiences of the Kyet-mauk-taung irrigation project in Burma, built in the middle of the country where water is relatively scarce. The study is to explore not only the irrigational aspects of the project, but additionally the evaluation of the whole project from the economic point of view. On the other hand, it also discussed the problems of water management and the provision of water for drinking purposes.

Water management, as it is already well known, is one of the most important problems in agricultural development. The total global water supply is more than sufficient to meet needs in the foreseeable future. The basic problem is the availability of water. As the United Nations Water Conference held in Argentina in 1977 emphasized in its report, water tends to be available in the wrong place at the wrong time or with the wrong quality. The solution is to move it locally to where people require it either through minor irrigation or by the use of large irrigation systems.

The study discusses the problem of transporting or storing of water in a region which is in urgent need. The project under consideration is one of the many governmental attempts in bringing some of the water scarce regions into water-fed agricultural ones. During the early 1960s the Government of Burma was actively developing a number of major irrigation works which included our present case-study. The project region lies in the arid zone of Central Burma, widely known as the Dry Zone Area. This is mainly because of its scarcity of water and high temperate climates. Therefore, a small local community living there found it extremely difficult to raise agricultural crops. Furthermore, the only means of livelihood for the people in the area was to produce jaggery from toddy-palm trees. This provided low incomes and was causing deforestation in the area. These factors led to the development of this dam which later came to be known as 'Kyet-mauk-taung'.

The main objectives of the study are to investigate three basic issues which are (1) to examine the economic effects of irrigation, both social and private, in the agricultural development of the region; (2) to examine the stabilizing effects of irrigation in a water-scarce arid zone; and (3) to make a social benefit-cost analysis of the project.

The study is divided into two main parts. The first part deals with a theoretical analysis of the economics of irrigation and its importance for agricultural development. The second part deals with an economic assessment of the project. In a sequence of chapters, Chapter 2 explains the agricultural economy of Burma in which irrigation plays a vital role. The theoretical aspects of irrigation economics are discussed in depth in the following chapter. An intensive study of the project itself begins in Chapter 4, where it covers a wide range of general techno-aspects from its historical background up to its present status. Project costs which involved the Soviet loan and other associated costs are discussed in Chapter 5. The problems connected with irrigational aspects of the project and the assessment of direct benefits involved are brought out in Chapter 6. An attempt to evaluate the project from an economic and social point of view is done in Chapter 7, followed by Chapter 8, which highlights the economic consequences of the project.

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* A map of Burma indicating the location of the project area is shown in Appendix.

CHAPTER 2

THE ROLE OF IRRIGATION IN BURMESE AGRICULTURE

Burma is an agricultural country. Irrigation had played a significant role in agricultural development ever since the days when Burmese kings reigned the country. Although the country is blessed with copious water supplies, irrigation is still regarded as an essential agricultural input due to distinct and short duration rainy seasons. Therefore, irrigation is a vital part of an overall agricultural development strategy.

Rainfall is abundant in most of Burma, with the exception of the dry area south and west of Mandalay, which is the old capital city in the middle of the country. This represents about 40 per cent of the total area. Nearly all the rainfall, however, falls during the months of May through to October. The Dry Zone in Central Burma is deficient in moisture even during the rainy season. Even areas of plentiful annual rainfall often suffer crop losses because the moisture does not occur at the proper time. In Central Burma, artificial irrigation is needed, and in Lower Burma water must be drained from the land as well as contained in the river channels by means of embankments if successful crop husbandry is to be undertaken.

Irrigation, flood control and drainage have been practised in Burma for centuries. The early, simple works were originally managed by men elected from among those who benefited from the installations. Centralized controls came into being but their activities were restricted to those works which could produce a profit and the other small irrigation projects were left to the management of the local committees.

A small percentage (12 per cent) of all cultivated land in Burma is now under irrigation. Most of the irrigation projects are government owned. Actually, the present projects and dams that have been created by the government were in most cases plans and works that were laid down and built by ancient Burmese kings. During the times of the Burmese kings, native-type irrigation systems were built just to boost agricultural production, not for the sake of exports as it is today, but for domestic consumption and self-sufficiency. The old irrigation systems were originally earthen dams representing technology of the time, especially with old Burmese type bricks, earth and wood, and are very different from mechanized modern projects of today.

The climate in Burma is tropical and is under the influence of the South-West Monsoon, which blows off the Indian Ocean, and the dry North-East Monsoon which comes from the Chinese mainland. There are three distinct seasons: a rainy season from May to mid-October; a cool season nearly rainless from mid-October to mid-February; and a hot season, also dry, from mid-February to mid-May. This gives two distinct crop seasons.

In the Irrawaddy Delta, the average annual rainfall ranges from about 140 inches near the coast to about 80 inches at the apex of the Delta, and averages about 100 inches over the whole Delta. 35 per cent of the annual rainfall occurs during the wet season and flooding is often a problem in that region. Even in the wet season, however, rainfall is erratic and supplementary irrigation did greatly improve crop yields. Irrigation is very much essential for the dry season crop cultivation. Rainfall in the Dry Zone Area of Upper Burma is much less than in other areas, averaging about 30 to 35 inches per year, and is also concentrated from May to October.* The need for irrigation is much more pronounced there than in Lower Burma.

In pre-colonial days, it has been known that Burmese kings often resorted to Burmese type irrigation systems to boost agricultural production. Some of the old irrigation systems date back to as early as the 9th Century. Many of the irrigation works used today were built and improved by the kings as early as the 10th Century.

In those days, Lower Burma was sparsely populated and its cultivable land largely unexploited. However, with the advent of colonialism, Lower Burma came to be populated and agricultural production, particularly paddy, began to increase by leaps and bounds. Since that agricultural development was linked with the development of exports, it was popularly attributed to the opening of the Suez Canal in 1869.

This agricultural development in Lower Burma, through the expansion of cultivated area, is of an extensive type requiring little or no irrigation. This can be seen from Tables 2.1 and 2.2 below.

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* A rainfall map is shown in Appendix.

TABLE 2.1

Output, Domestic Utilization and Exports of Rice

(000 tons, paddy)

Year	Output	Domestic Utilization	Exports	Domestic Utilization (% of output)	Exports (% of output)
1895	3619	1871	1748	51.7	48.3
1905	4345	1446	2899	33.3	66.7
1925	6720	2368	4352	35.2	64.8
1940	7910	4164	3746	52.6	47.4

Source: Department of Economics, Rangoon University, Rangoon, 1956.

TABLE 2.2

Cultivated Land Under Paddy in Colonial Period

('000 acres)

Year	Lower Burma	Upper Burma	Total
1845	354	-	354
1890	4398	1357	5755
1936	9855	2019	11874

Source: Department of Economics, Rangoon University, Rangoon, 1956.

It will be seen from Table 2.1 that the production of paddy, which is the main staple food and the predominant crop in the country, increased tremendously during the period considered. It increased to such an extent that it was not only able to provide an increasing food supply to the increasing indigenous population (with the natural rate of growth of 1 per cent to 1.5 per cent per annum), but also contribute to a growing volume of exports. Table 2.2 clearly shows that increase in paddy production was largely due to the expansion of cultivated area.

During the whole colonial period, what irrigation works there were were mainly in the form of reconstruction of old weirs, tanks and dams, and these were mainly confined to Upper Burma. In 1940-41, the total irrigated area of 1,562,000 acres was merely 9 per cent of the net sown area. What happened was a number of irrigation projects were undertaken and completed, and the percentage of the irrigated area increased to over 11 per cent of the sown area by the end of 1972-73. See Table 2.3.

TABLE 2.3

Progress in Irrigated Area

('000 acres)

Year	Irrigated Area	Net Sown Area	Irrigated Area as Percentage of Net Sown Area
1940-41	1562	17560	8.89
1947-48	1327	14008	9.47
1961-62	1324	17698	7.48
1964-65	1941	19623	9.89
1968-69	2017	19261	10.47
1969-70	2020	19219	10.51
1970-71	2073	19512	10.62
1971-72	2199	19674	11.18
1972-73	2198	19482	11.28

Source: Report to the Pyithu Hluttaw, 1979-80

It will be seen from the table that the area under irrigation increased both absolutely and relatively over the period considered, although the increase (percentage wise) may not have been awe inspiring.

If we look at the progress in irrigated area sown more than once, however, the increase in irrigated area is quite substantial. See Table 2.4

It may be seen from the table that multiple cropped area under irrigation grew from 6.24 per cent in 1961-62 to 13.83 per cent of total irrigated area in 1972-73. But it must be admitted that the major benefits of irrigation have still been largely supplemental irrigation during the monsoon to increase yields of rain-fed crops. This is further supported by Table 2.5, which shows the irrigated area by crops.

TABLE 2.4

Progress in Irrigated Area Sown More Than Once

(Acres)

Year	Irrigated Area	Irrigated Area Sown More Than Once	Percentage
1961-62	1324263	82634	6.24
1964-65	1941236	160055	8.25
1968-69	2016714	251029	12.45
1969-70	2020155	270359	13.38
1970-71	2073169	264502	12.76
1971-72	2199079	299853	13.64
1972-73	2197815	303889	13.83

Source: Report to the People, 1976-77

TABLE 2.5

Irrigated Area by Crops (Acres)

(Including Areas of Crops Sown More Than Once)

Crops	1961-62	% of Gross Cropped Area	1972-73	% of Gross Cropped Area
1. Paddy	1168128	83.0	1809715	72.0
2. Wheat	6149	0.4	1489	0.06
3. Maize	4097	0.2	2849	0.11
4. Other Cereals	248	0.02	5355	0.21
5. Pulses	60178	4.2	83850	3.35
6. Sugar Cane	5989	6.4	15479	0.61
7. Other Edible Crops	123776	8.7	228628	9.13
8. Cotton	8615	0.6	175700	7.02
9. Jute	-	-	183729	7.34
10. Other Non-Edible Crops	29717	2.1	13110	0.52
Total	1324263		2197815	

Source: Report to the People, 1976-77.

An analysis of Table 2.5 shows that paddy occupies the largest area and constitutes 1.8 million acres or nearly 72 per cent of the total irrigated crop area. Other industrial crops, namely jute, cotton, and sugar cane were also given priority in irrigation, but relatively less significant in terms of total irrigated area.

Finally, the breakdown of the total irrigated area by different types of irrigation shown in Table 2.6 below, shows the predominance of surface gravity irrigation.

TABLE 2.6

Irrigated Area by Various Means of Irrigation

(Acres)

Particulars	1961-62	% of Total Irrigated Area	1972-73	% of Total Irrigated Area
1. Canals	973889	71.28	1464131	66.63
2. Tanks	163317	12.34	173526	7.89
3. Wells	23966	1.80	33851	1.54
4. Pumps	-		248361	11.30
5. Windmills	-		1106	0.65
6. Others	193091	14.58	276840	12.59
Total	1324263		2197815	

Source: Report to the People, 1976-77.

The progress of irrigation has helped to expand the area under cultivation. The area under cultivation was expanded from about 19 million acres in 1961-62 to well over 22 million acres in 1972-73. It should be noted that this increase in cultivated area was made possible by the progress in supplemental gravity flow irrigation from which we may infer that any increase in cultivable area in the future would either require irrigation or drainage, or both.

As can be seen from Table 2.6, irrigation by canals plays the dominant role. It was only in 1972-73, that irrigation by pumps and windmills came into use. Although various means of irrigation increased, sown acreage under paddy, the dominant crop, failed to increase significantly. Over a span of eleven years, its average annual compound rate of growth could not have been more than 0.5 per cent. This was primarily due to the low procurement price of paddy.*

Apart from the low price of paddy, attempts to provide farm inputs such as fertilizers, improved seeds and pesticides have also been only partially successful. As a consequence, yield per acre of paddy hovered around 34 baskets per acre, depending upon the state of the weather, and agricultural output had grown at an average annual rate of 1 per cent to 2 per cent or less; thereby lagging behind population which had grown at a rate of about 2.2 per cent per annum over the last decade.

Nevertheless, there was a possibility for an agricultural breakthrough. With an increasing realization that agriculture must be given priority, came also the realization that this must be accomplished not only with an increase in irrigation and drainage coupled with increased supplies of farm inputs such as fertilizers, improved seeds, pesticides and mechanical plus animal power, but also with proper price incentives.

Since 1972-73, area under irrigation as a percentage of total cultivable area grew only slightly from over 11 per cent to 12.5 per cent. See Table 2.7. Although the increase in the net sown area was not significant, there was an increase in the production of paddy per acre from 34 baskets per acre to 40 baskets per acre in 1978-79. And because of this increase in productivity per acre, overall production of paddy began to top the mark of 9 million tons for the first time in 1975-76.

As already mentioned, among the crops under irrigation, paddy is the most important, for both exports and domestic consumption. Little increase and slight changes in the irrigated areas of pulses, groundnut and maize were seen during the period before 1960-61. Irrigated area under sugar cane was also very small. During the years from 1973-74 to 1978-79, as can be seen from Table 2.7, there was little or no significant change in total irrigated area of the country.

Small increases in total irrigated area were due to increased sown acreage of pulses and maize, which were grown mostly for exports. Before 1960-61, the government built quite a number of irrigation projects in Upper and Central Burma which added much to some old

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* The price of paddy was raised from Ks.425 per 100 baskets in the 1960s to Ks.600 in 1973-74 and again to Ks.900 in 1974-75.

irrigation systems and their irrigated capacity.

TABLE 2.7

Progress in Irrigated Area

('000 Acres)

Year	Irrigated Area	Net Sown Area	Percentage	Average Per Acre Yield of Paddy (Baskets)
1973-74	2400	19927	12.04	34.19
1974-75	2414	20023	12.05	34.09
1975-76	2432	20088	12.11	35.51
1976-77	2418	19838	11.68	36.80
1977-78	2422	20041	12.09	37.73
1978-79	2550	20370	12.52	37.73

Source: Report to the Phyithu Hluttaw, 1979-80

Irrigation by tanks were practised earlier than irrigation by weirs, and were supposed to be the earliest irrigation systems in Burma. Also, it has lesser importance than irrigation by diversion weirs, for the latter have greater irrigated capacity. Nowadays, Burma enjoys different modern types of irrigation such as pump irrigation, embankments, flood controls and sprinkler irrigation.

Government policy has tended to place irrigation in a more important role than before, as one of the most basic and important factors in agricultural development. Given that irrigation will be a vital part of an overall agricultural development strategy, it is most imperative that the realistic reassessment of irrigation projects be made. In this respect, it is essential to accelerate research activities to improve the efficiency of irrigation management and the economy of water use in project areas. Benefits from costly major irrigation projects can only be maximized when both the irrigation management and the use of water can meet particular agronomic requirements under different soil types, cropping patterns, cropping seasons and prevailing weather conditions.

The Kyet-mauk-taung region under consideration has relatively low annual rainfall in contrast with other areas of the country. For the sake of agriculture, there were indeed urgent needs for provision of irrigation systems in the region and hence feasibility studies were made beforehand. The possible means of irrigation was damming the two rivers that exist in the area. Other means which may include tube-wells or pumps were out of the question simply because of low underground water tables.

The construction of an irrigation dam in the region was, in fact, part of the broad campaign of boosting agricultural production through irrigation in the Dry Zone Area. The government realized the important role irrigation would play and on the other hand there was no doubt that life would be much better or easier with irrigation because contrary to what is happening in the present, the local people had struggled for survival with minimum subsistence levels. Given its pre-irrigation conditions, the irrigation project has helped the development of the region.

CHAPTER 3

ECONOMICS OF IRRIGATION

3.1 Economics of Irrigated Agriculture

'Irrigation' is the artificial supply of water to cultivated crops from a storage reservoir or stream diversion or by lifting. Drainage is part of any irrigation development because land irrigated without a proper natural or man-made drainage system can become water-logged. Irrigation of crops is not necessary in areas with sufficient rainfall for crop requirements, provided rainfall occurs at the time needed. Areas with adequate annual rainfall, the occurrence of which is not the times needed, will benefit from supplementary irrigation at times during the growing season when rainfall and soil moisture are deficient. Areas with low rainfall must be definitely supplied from artificial irrigation if there is to be crop production. Thus irrigation helps in extending or stabilizing the crop calendar. Even when rainfall is reasonably adequate, availability of irrigation provides stability to crop production through management of water.

The main objective of irrigation is to serve two purposes, namely, 'production' and 'protection'. In this respect, irrigation plays an important role in agricultural development, for it is largely for the purpose of increasing agricultural production. Irrigated agriculture, thus provides a basis for further economic development. Public irrigation projects, as well as other engineering and agricultural works, are not only for the purpose of increased agricultural production, but also protection against drought, dryness, famine, etc. Irrigation in humid climate areas:

(a) controls soil mositure and overcomes the problems created by drought;

(b) provides green pasture and green food for milch and work animals;

(c) makes double and multiple cropping possible which would positively result in increased production;

(d) aids the bacterial and chemical activities of the soil;

(e) improves plant quality and aids control of crop pests and diseases;

(f) increases soil moisture during the growing season;

(g) aids in deep or early fall ploughing and extensive cropping; and,

(h) pays in increased yields and higher value of output.

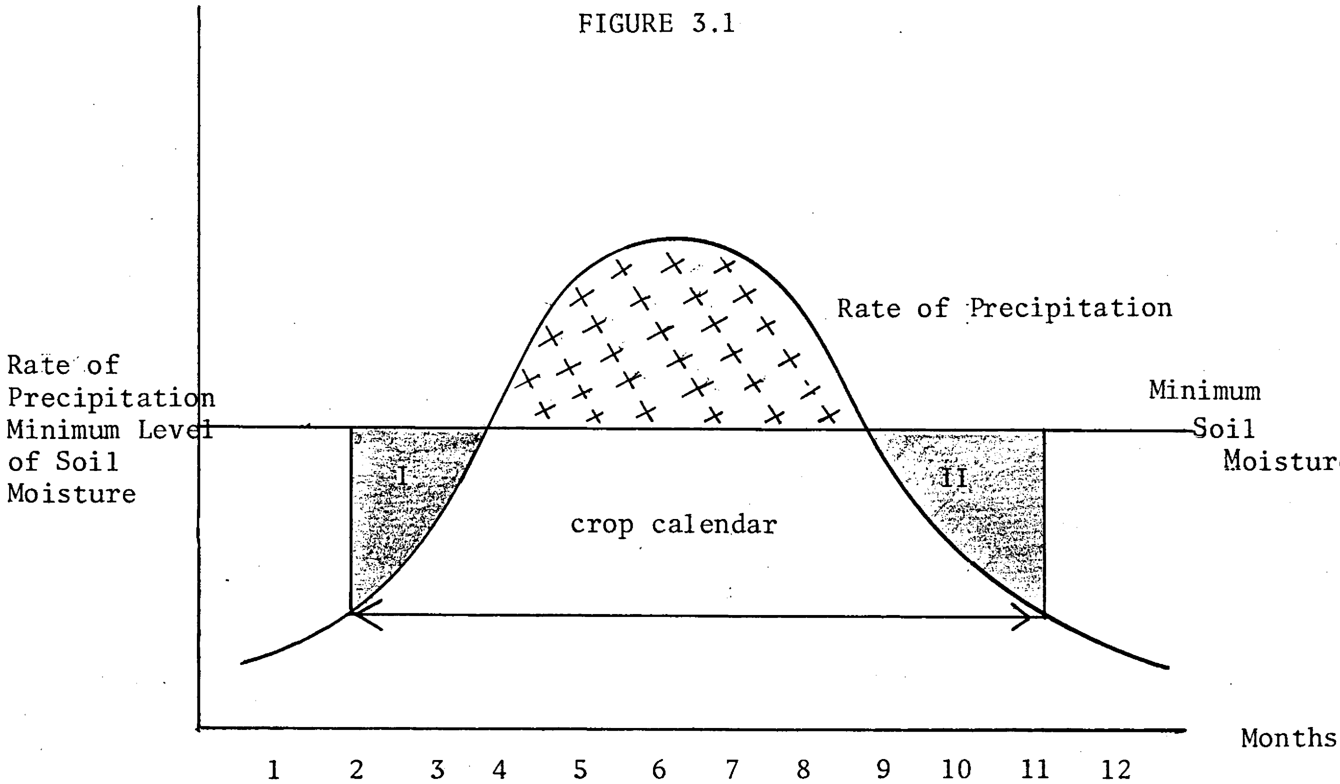
A well established fact is that farmers in humid areas can assure themselves of larger and more dependable crop yields, insofar as influenced by available soil moisture, by providing irrigation systems and dependable water supplies. But this fact does not prove that the farmers' profits will thus be increased. Humid climate farmers should consider irrigation as a possible means of improving their economic status.

A key decision in designing an irrigation system is to establish the water requirements. The designed water requirements determine either the maximum area that can be served or, if the area is specified, the amount of the required water supply. The water requirement is the basic parameter dictating channel water-carrying capacity, and has implications for the physical, economic and social environment locally. The estimated water requirement needed to be stored in a reservoir is based on potential precipitation rate of rainfall and the level of soil moisture. Any amount of precipitation rate over and above the level of soil moisture can be stored during a certain period of time. With this storage of water, there can be a possible extension of the crop calendar.

Figure 1 shows the relationship between the rate of precipitation, the required minimum level of soil moisture and the crop calendar. This is supposed to be for an area where agriculture depends heavily on natural rainfall, and is assumed that rains occur only from the fourth month to the ninth month of the year. For a given level of soil moisture needed for the growth of crops, agriculture is only possible within a limited range of rainfall periods. The crop calendar as shown in the diagram is limited by the curve of the rate of precipitation. If any excess of rainfall above the level of soil moisture is properly stored in shaded areas of I and II, which would otherwise have been wasted, the crop calendar may be expanded to periods where rainfalls do not occur. In this way, instead of a mono-crop, there is a possibility of a multi-crop culture.

Development of irrigation is an important element in agricultural development. There are mainly two main types of irrigation, namely gravity irrigation and lift irrigation systems. The former is commonly

FIGURE 3.1



known as surface irrigation, where irrigation comes from storage tanks and reservoirs. Reservoir water is received from various combinations of catchment run-off and river diversions. Distribution of water from the reservoir is done by gravity flow through main canals and channels of diminishing sizes to farms.

Lift irrigation is the form of water being lifted from underground water tables by means of high-powered pumps, which later are distributed by the same means as gravity flow irrigation. There are also other types of lift irrigation, for example, man-made wells, tube wells and sprinkler systems which fall in the same category.*

Any type of irrigation, surface gravity or lift irrigation, depends heavily on the water balance and the ground water tables. In the case of lift irrigation, water levels in the sub-soil determines the availability of water resources. For surface gravity, a water balance is the most important which is, by definition, the book-keeping of volume of water entering and leaving or being stored in a system during a

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* For details of other typologies of irrigation systems, see 'Water Resource Project Planning', Water Resources Series No.41, United Nations, 1972.

certain period of time.

Irrigation can be created by individual producers if the water table is high and where tube-well irrigation is feasible. Similarly, a group of producers can jointly store water if water can be stored in small tanks surrounded by agricultural fields. In more difficult situations, a major diversion and damming of a river, or joining of rivers is needed. In such a situation, a major public investment is needed. The role of the state in the first two can be at best facilitating, but in the last case it has to be enabling.

The establishment of major irrigation projects in the public sector depends heavily on the regional hydro-geological situation. Rainfall in the project area and in the whole catchment basin must be estimated. It will also be necessary to estimate rainfall for different climatic zones in the area as a whole. Statistics of monthly rainfall should be recorded for each zone. Averages should be calculated for over thirty years or more. It is useful to estimate rainfall in the irrigation area because of its direct relationship with the requirements of irrigation water. The distribution and frequency of the monthly rainfall are, therefore, key factors. If possible, the frequency and intensity of daily rainfall should also be determined if any problems of surface drainage arise.

Temperature within the project area is the second most important climatic factor. With monthly temperature statistics, average evapotranspiration in the area can be estimated. Monthly hours of sunshine and the degree of humidity are needed for the necessary estimates.

Soil maps showing the relative suitability for irrigation of the different soils should also be made before any system of irrigation is established. A soil classification survey should be conducted for allowing the best type of crops to be cultivated after completion of a project. In this way, certain yields can be predicted for certain crops. In connection with this, attention should also be paid to the danger of land erosion which might either reduce the area for irrigation, or necessitate soil protection and restoration measures, thus adding to the total investment outlay. It is essential to know the rate of erosion above the irrigation system and storage dam in order to estimate the probable sedimentation.

The hydrological and hydrogeological data are based on rainfall runoff in the catchment basins. Hydrological studies should be done on monthly water supplies both within the project area and at points where water can be stored or dammed. The maximum and minimum water flows must be determined. From the hydrogeological viewpoint, it is important to estimate the nature and size of the water bearing formations, the position of water levels and their seasonal fluctuations. This could be done by regular recording and the geophysical measurement of water levels. Generally speaking, the study and estimation of water resources are of considerable importance, because the measured quantities of water would have a major influence upon the expected agricultural production.

The creation of an irrigation network should be suitable for the topology or ecology of the project area. It includes the traditional surface irrigation, types of canals and channels, methods of watering and all related works. Pre-project plans should include designs for dams based on topographical surveys of the sites. Canals and main channels should also be based on topographical surveys or detailed maps. It is essential that the general plan of the network of distribution channels is carefully implemented. The network will have to ensure that all land is provided with both water and drainage.

Public investments for irrigation systems cover all costs which may involve preliminary surveys, plans and designs, construction of the dam and its supporting structures, the network of irrigation canals, material equipment and funds for labour and the management body. In some cases, it involves foreign cost which may include equipment and technicians. A financial plan should be drawn with a clear distinction of capital cost requirements between domestic currency and foreign exchange expenditure. After the financial requirements are determined the sources from which they may be covered must be identified. For major projects, most of the capital cost may be financed by public funds which originate from annual budgets or from capital resources drawn from specific government revenue. In the case of a foreign loan, the duration and the rate of interest along with the dates of principal repayments and interest charges must be considered. Since major irrigation projects involve huge public investment of labour and capital, there is a need for its economic and social evaluation.

Investment costs for public irrigation projects are mostly incurred by the state. Construction of a major project imposes two primary demands of real resources on the economy, namely labour which represents direct factor demands and materials, equipment and supplies which have certain opportunity costs. Because major works involve considerable economic costs and because there is a long gestation period, these are usually borne by the state. In other words, it is a public investment.

As irrigation is regarded as one of the primary requirements of agricultural development, a great deal of attention is being placed upon public investments in such works. There are two related questions involved in irrigation policy. One is the public investment allocation to irrigation. Another is the recovery of costs involved. The first is concerned with the undertaking of a major public investment project and hence the need for studying the opportunity costs of public resources. In addition, it is important for most governments to decide upon establishment of such systems not on direct economic considerations alone but more importantly on social and regional development conditions.**

The other question which is related with the recoupment of costs is directly concerned with the economic profitability of the projects. As far as the recovery of costs are concerned, there are several ways in which this may be done:

(a) capital investment fully financed by the beneficiaries in the irrigated area;
(b) a capital levy to be paid by the beneficiaries;
(c) charging of irrigation water rates; and,
(d) public investment borne by the society.

Private investment depends on the interest and co-operation of the beneficiaries themselves. In this respect, it is important to know the attitude of farmers towards development of irrigation systems and their expectations for future changes in the local agriculture. Government policies should also tend to encourage private investments in areas where public funds cannot be allocated. In this case, consideration must also be given to loans and subsidies by the government.

On the other hand, a capital levy to be paid by the beneficiaries or the water charges will obviously depend upon government policies.

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* Detailed discussions of the planning process on the scope of water resources planning can be found in 'Water Resource Project Planning', Water Resource Series No. 41, United Nations, 1972.

** The opportunity costs of public resources involved in major irrigation systems are discussed widely in later chapters.

Here, the main objective is the reimbursement of the partial or total investment used for irrigation. For social reasons, charges on water rates and capital charges will have to be reasonably fixed. The fixation of irrigation rates has a direct relationship with the extent and nature of utilization of the irrigation potential.*

After the establishment of irrigation systems, a proper water management and a proper allocation procedure and use of water should also be considered. A central and universal issue in the distribution of water is when and where irrigation water is distributed to farmers. When water is scarce and often constraining, where individual farmers have to compete for it, the focus is on the allocation and acquisition which determines the access of users to water.

On the other hand, there is increased awareness of the critical role that institutions and organizations play in the process of irrigation development. Obviously, the success of an irrigation project depends largely not only on irrigation authorities alone but also on the active participation and co-operation of individual farmers. Therefore, a group such as farmers' association should be organized with initial government assistance, to help in attaining the objectives of an irrigation project.

Needless to say, the supporting facilities have equal importance along with factors directly affecting the project and its beneficiaries. These include markets for both inputs and outputs, agricultural extension services and influential government policies. There must be an organized well-established market for agricultural inputs, if the farmers are to make the best use of irrigation. Prices should be reasonable and governments should exercise control to hinder severe distortions in the market. Government policies should also be implemented to have easy access of major inputs such as credit, fertilizers, etc., to farmers.

3.2 Irrigation Costs

Economic and financial analyses are performed to establish the soundness of a project. Soundness analyses are a judgement to evaluate the undertaking or financing of a potential project. Economic

* The fixation of irrigation rates is discussed in detail in the later chapters. Irrigation potential is by definition the area that a given irrigation work can irrigate. It thus measures the capacity of an irrigation work.

analysis is mostly concerned with the economic feasibility of a project, while financial analysis is related to its viability. The latter makes sure that the execution of a project is properly financed, its cost recovered, and cash flow problems do not arise.

There are two main cost components which consist in the total project cost, namely the capital investment cost and annual or recurring costs. The former costs are mainly for investigation, planning and the execution of a project which can be broken down into separate cost components, such as:

(a) costs for pre-project exploration and study;
(b) costs for planning and design;
(c) construction costs and other associated costs;
(d) costs for resettlement and relocation;
(e) associated development costs;
(f) environmental development costs;
(g) cost for personnel training.

Most capital costs can be measured as monetary costs in terms of market prices or in some cases in terms of shadow prices. If the construction of a project is arranged with private contracts, all monetary costs would include payments for services, materials, equipment and land. In most state-controlled societies, these cost categories are met by the government itself. In this case, total costs from project survey to the final execution of the project are incurred by the state.

Costs for pre-project exploration are those for engineering or geological surveys, administration and laboratory works. Costs for planning and design may include detailed designs and construction drawings.

Construction costs which are supposed to be the main cost component, are cost for execution of project works. This will, of course, include costs for engineering and administrative purposes. There is also a need for a contingency fund in cases for discrepancies between estimated and actual costs or for unforeseeable difficulties and charges, which is always the case. The fund would be no more than a small percentage of the total costs.

There is a special cost component concerned with the resettlement and rehabilitation. These costs are for the removal of local inhabitants from the catchment areas. The responsibility of the government is to ascertain that these displaced people are resettled with the least disruption to their ability of earning a livelihood. Sometimes there are social and political constraints placed upon the authorities in evacuating them. Usually, the government pays financial compensation for all social and economic losses, which is often taken into account as one of the project costs.

The above constitute costs which are before or during the period of construction of a project. Costs after the project also formed a major component in total costs and are regarded as equally important to costs before the project. Costs which fall into this category are development costs, environmental costs and annual operation and maintenance costs. Development costs are those for land consolidation, demonstration farms, extension services, farm credit, storage and transportation. Environmental costs are costs that add to the natural quality or beauty of a project.

Training cost for skilled personnel are also to be regarded as costs, for these ensure successful operation and management of a project. Skill and knowledge of the working staff can be improved through a well-planned training program during or after construction periods.*

Annual costs for operation and maintenance represent costs for materials, equipment, administrative or management and others to keep the project in efficient operation. Annual recurring costs may include:

(a) wages and salaries;
(b) costs for replacement of equipment and materials;
(c) costs for repairs and maintenance.

Wages and salaries are paid for administrative and management services to those who operate the project. Costs for replacement of equipment and materials are usually estimated and met by a reserve fund. Costs for repairs and maintenance are mainly for physical wear and tear or obsolescence. In cases for irrigation projects, costs for maintenance are not only for those equipment installed in the project but more importantly for canal distribution systems. Replacement costs may not be on a yearly basis but it is usually the

* This is widely discussed in 'Economic Aspects of the Bhakra Nangal Project', K.N. Raj, Delhi School of Economics, May, 1959, and 'Economics of Irrigation Rates', Nasim Ansari, University of Delhi, 1968.

case in costs for repairs and maintenance.

All costs that are relevant in the computation of profitability from a financial point of view are the actual costs evaluated at internal market prices. Assuming the internal market is close to perfectly competitive market, the best prices one could normally use will be the market prices. In the first place all goods and services involved in carrying out the project or operating it will have to be valued at market prices.

The use of market prices may be improper, since in practice there are imperfections in the market. If it is the case, then such prices may not be equal to prices which may reflect true social costs. It is therefore necessary to evaluate costs at appropriate prices which may represent their true cost to the society.

If a project involves goods and services which can be considered as tradeables, the most appropriate prices to use according to some writers are the international prices in place of internal market prices. Reasons behind this are that world market prices are believed to be more or less close to prices in the perfect market.

For all goods and services where there is neither an international price nor an internal competitive market price, the real cost is the social opportunity cost. This is obviously true in the case of family labour. There is an opportunity cost involved in employing labour in a project. The true value of labour in situations of unemployment is often very close to its subsistence level and usually it is far below the nominal wages at market prices. For projects which may involve certain skilled labour such as experts and technicians, it is necessary to value such type of labour at the cost of imported labour.

The fact that irrigation projects as well as other projects involved both local and foreign resources, means that these foreign resources must also be valued at their true social cost. This would not have been too difficult if it were not for the fact of price and market distortions in many developing countries which usually makes official rate of exchange unsuitable for the purpose in hand.* Hence, projects which involve foreign resources are apt to use shadow exchange rates which reflect true values of any foreign exchange cost component.

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* The use of shadow prices for labour or foreign exchange is discussed in later parts of this chapter.

On the other hand, for reasons which need no elaboration, projects usually take longer than expected. In the mean time prices may have risen from the very inception of the project. In many cases, the increase in prices can also be quite significant. Hence, costs overrun due to any physical contingencies or price increases has to be allowed for in the estimation of project costs.

3.3 Economic Benefits of Irrigation

The difference in total economic and agricultural income 'with' and 'without' the project during its economic life, is regarded as the economic contribution or economic returns of the project.

If we are to compare the economic nature of alternative irrigation projects, economic efficiency of each project must be computed or calculated by means of a cost-benefit ratio or any other economic criterion. Economic efficiency is expressed in terms of a comparison of the values of outputs and inputs,simply expressed as project benefits and costs respectively. While project costs can be clearly defined in concrete measurements, project benefits are difficult to define. Measurement of project benefits varies among countries, depending on economic policies, economic criteria and values and any economic information available. Economic benefits of an irrigation project can be classified in three categories, namely,

(1) primary benefits;
(2) secondary benefits; and
(3) intangible benefits.

The primary benefits which are normally known as direct benefits are the increase in the net gains from the farm production of more grains, crops and other farm products. In other words, it is the net gain accruing to an average farm multiplied by the total number of farms in the irrigated area, or some similar measure.

The increase in farm production is mainly due to (a) increase in crop yields, (b) increase in the total farming area. Irrigation can provide security and freedom of farm cultivation from shortage of rainfall, drought, dryness, etc. By taming the floods it can at least prevent some frequent crop failures. Lessening the chances of crop failures means increasing the chances for crop maturings; thus leading to increase in agricultural output. Irrigation plus other scientific, systematic methods of farm cultivation will certainly increase different crop yields, especially in water-scarce arid areas. Crop yield is one of the main factors in making up the total amount of agricultural production and hence by increasing yields, irrigation helps boost agricultural production.

Estimation and yield projections for a number of major crops grown in different project areas, and forecasting these changes is one of the most critical parts of project planning. Irrigation may also increase the total gross farming area either by bringing new lands under cultivation or by transforming single cropped areas into double-crop areas. We can estimate the gross gain by multiplying the increase in cultivated area by the increase in yield for different crops.

The basic data for these calculations are usually drawn from land classification survey and farm budget studies. To provide a basis for planning in the project area, a land classification survey is firstly performed. This survey will evaluate the land productivity with and without irrigation, to determine water requirements and the requirement of production cost. The survey also provides information on development costs of new lands for farming purposes, including land clearing, levelling, soil amendment, and farm ditches for water distribution and drainage at the farm level. Farm budget studies provide output, production expenses, and farm family living expenses with and without irrigation.

For the survey and farm budget analysis, sample farms may be selected from each of the different classes of land. If farms vary widely in size, a selection of an adequate number of samples representing blocks of farm sizes can be done. Consideration must also be given to location of the sample farms with respect to the canal systems. In an area where land is highly fragmented, a large number of farm samples will be needed. If there exists in the project area or in the neighbouring area farms having adequate water supply, they provide useful samples in the farm budget analysis. This will determine land productivity and net farming gains when irrigation is provided to the project area.

As mentioned earlier, estimation of benefits is always a difficult and uncertain business. In fact, economic benefits in the appraisal of a large number of irrigation projects in underdeveloped countries is more or less done without any farm budget studies. All necessary computations for estimation of direct benefits are simply done on the basis of experimental farms.

Again when comparing 'with' and 'without' irrigation situations, the practice until recently has been to compare the present situation 'without' irrigation with the future situation 'with' irrigation. A more appropriate procedure is to compare the future situation 'without' irrigation with the future situation 'with' irrigation. Indeed, this is the procedure followed by the World Bank in the appraisal of irrigation projects.

The secondary benefits which are normally known as the indirect benefits are those increases in the net gains from activities induced by the primary benefits. They are as follows:

(1) farm profits of local wholesales and retailers in handling the increase in sales of farm products consumed locally in the project area without processing;
(2) profits of all enterprises from handling, processing and marketing of farm products locally or elsewhere between the farm and the final consumer;
(3) profits of all enterprises from supplying goods and services to farm families in the increase of farm purchases for family living and production expenses;
(4) increase in the land value in the locality.

In an economy with a large amount of unused resources, for example labour, a primary investment such as an investment in irrigation may create a demand for these resources. Thus it could be a social benefit to the society in employing these resources which would otherwise have remained idle. In fact, indirect benefits are also equally as important as direct benefits because in many developing countries there are abundant labour and land resources, and construction of irrigation projects and increased farming with irrigation would obviously mean employment for more labour and more agricultural use of land.

In many land scarce developing countries, there is a significant existence of unemployment. On the other hand, there is also a great scarcity of capital and skilled labour. There can be different degrees of unemployment of factors of production in different areas of the same region; and these resources can also be immobile. In this respect, if these resources can be easily mobilized, it is of considerable importance to take into account secondary benefits and external economies such as employment of labour and labour movement to places where the need arises.

Another crucial aspect is that the technological spillover should be considered if we are concerned with maximizing the real national product. For example, the creation of drainage problems near a reservoir is a cost that should be considered, while the provision of flood control downstream of a dam is a benefit that should be considered even if the dam was constructed solely for the purpose of water supply. On the other hand, pecuniary spillover effects should also be considered. A pecuniary spillover effect to labour occurs when the establishment of an irrigation project increases the labour price in nearby areas; and in another respect if the project produces, for example, cotton in sufficient quantity to drive down its price, competing cotton growers in nearby areas would suffer a pecuniary spillover loss.

There are benefits which cannot be expressed in monetary terms but these could be decisive importance. These are the intangible benefits. In other words, intangible benefits are those which cannot be measured in terms of monetary or physical measures. Some examples are reduction in loss of life, enhancement of the general welfare and security of the people, improvement of sanitation and protection against epidemics. Loss of human lives is, of course, a very important item in the field of flood protection.

Among intangible benefits, enhancement of general welfare is one of the most difficult to express. They are often not only immeasurable, but beyond specific description. There is yet another aspect of flood control works which is of importance to the general welfare, i.e. the possibility of increasing employment in an underdeveloped region by execution of such works. Intangible benefits in public health are very real too, thanks to the fact that sanitary precautions all over the world have improved so much that the adverse medical consequences of flooding can often be minimised.

Beneficial effects of a water resource development differ among project purposes. Their measurement varies with economic conditions and national policy. Some benefits may be hard to evaluate but they are all important considerations in determining the most feasible project. Such beneficial items may include life saving, social well-being, increased employment, economic growth stability, increased settlement opportunity, improvement in public health.

Measurement of benefits is categorized according to project functions:

(1) Benefits from domestic and industrial water supplies are measured in terms of improved public health, reduced fire hazard and more pleasant living environment;

(2) Flood control benefits arise from reduction in losses not only to human lives but also to land and property, and increase in net worth of real estate or land utilization;

(3) Navigation benefits are measured by savings in cost of transportation resulting from improved means of transport, as well as the increase in water traffic volume arising from project implementation;

(4) Hydro-power benefits are measured in terms of hydro power or water power, better living conveniences, conservation of fossil fuel resources for other alternative uses;

(5) Fish and wild life benefits come mainly from increase in commercial fish harvest and in sport fishing because of the project;

(6) Recreational benefits are often difficult to measure but may be accounted as some measure of the amount a vacationer is willing to pay for his enjoyment;

(7) Benefits such as watershed management and soil conservation aims at preserving the earth's fertility and productivity.

3.4 The Problems of Irrigation Pricing

There are several questions which are mainly concerned with the problem of irrigation pricing. One important question relates to how high must the irrigation rates be. This rests more or less on the consideration of irrigation authorities whether they should charge a rate which may earn a profit on irrigation, or whether rates should be fixed on a no-profit no-loss basis.

Another important question is concerned with the method of charging for irrigation water which is normally based upon per unit of land or per unit of water. In the earlier days, charges for irrigation rates were made upon the useage of the volume of water, and this was emphasized from the point of view of avoiding wastage of water. It is often argued that this acreage method would leave the farmer with no incentives to economize upon water, for his payments seemed to be unrelated to the quantum of water used by him. On the other hand, there is also another method where irrigation rates are fixed according to crop. Different crops have different water or irrigation requirements, and therefore, according to this method, there could be variations in charges between crops in proportion to their water requirements.

There are three alternative principles in charging irrigation rates; namely, the average cost principle, the marginal cost principle, and the net benefit principle.*

The net benefit principle requires a constant proportion of benefits attributable to irrigation. Marginal cost pricing and average cost pricing are related to the problems of pricing of services performed by public utilities. It has been assumed that general pricing is done at the point where the marginal cost curve intersects the average cost curve. In the real world, there might be such situations where costs are not sufficiently large enough to result in a rising average cost curve; which means that the marginal cost curve might always be below the average cost curve.

In such a case, those who propose the marginal cost principle pointed out the social losses involved in average cost pricing. On the other hand, rates charged at a point where the demand curve meets the average cost curve would enable not only for full utilization of irrigation water but would also recover costs. Charging rates before full capacity of utilization would shift the rates higher. This is very likely to happen in dry regions. If the demand for water is likely to meet the full capacity of supply, there is no need for a marginal cost pricing.**

Factors that change demand for irrigation are climate, rainfall, soil conditions, cropping patterns and techniques of agriculture. In years of low rainfall, the demand for irrigation increases. Changes in the cropping pattern would also affect demand. Similarly, changes in agricultural techniques would affect demand.

Costs could only be recovered by fixing rates on the basis of an average cost principle. If the rate is being fixed before full capacity

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* These principles are widely discussed in 'Economics of Irrigation Rates', Nasim Ansari, University of Delhi, 1968.

** The literature on irrigation pricing can also be found in 'Economic Study of Keepit Dam', International Engineering Service Consortium, 1969, and 'Benefit-cost Analysis of the Sarda Canal System', Baljit Singh and Shridhar Misra, Lucknow University, 1960.

of utilization, it is likely to involve wasteful allocation of resources. Fixing a rate where there is maximum utilization is a more rational behaviour. Suppose the rate is fixed below the average cost, it would obviously involve a loss to the government. On the other hand, if total consumers' surplus is higher than the accounted loss, any fixation of rates can be justified as socially beneficial.

Average cost pricing can be on different principles even in a region depending on the wide variations of costs of irrigation works. Therefore, following the above arguments, the net benefit principle becomes more desirable to economists compared with the other principles. In this respect, it would be more convenient to have a uniform rate in the country if not in a region. On the other side, a uniformity of rates seems to be almost impossible.

Another aspect of viewing this, rather than the average or the marginal cost pricing, is the direct and indirect benefits of irrigation. If an irrigation project is undertaken mainly because of indirect benefits, irrigation rates may not be chargeable. Further, if direct benefits are lower than costs, charging of rates is desirable but this will have to be kept lower than costs.

Another argument is the fixation of rates for different crops in proportion to the quantities of water used by them, which can be termed as volumetric charging. As already mentioned, it would provide inducement to farmers to economize upon the use of water to the possible maximum extent. Even if this is the case, it is likely to create a lot of problems in real practice.*

The governments in some countries like Burma and Sri Lanka supply irrigation to the farmers. In such situations water rationing is not done through pricing but through other social institutions. The total cost of irrigation projects in these countries has to be met from general taxes. The welfare of the direct beneficiaries improves at the cost of those from whom taxes have been collected but no direct benefit accrues from the project.

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* See Clark, Colin, 'The Economics of Irrigation', University of Oxford Agricultural Economics Research Institute, 1967.

3.5 Economic Evaluation of an Irrigation Project

There are several ways of evaluating an irrigation project. For any project, the most important concern is the return to the society of the resources committed to the project. In project analysis, there is a sharp contrast between a financial analysis and an economic analysis. If the evaluation of a project is concerned with financial returns mainly, it may be termed as the financial analysis. Some economists define the financial return as the direct returns valued at market prices. A financial analysis may also be applied to huge public sector investments.

A financial analysis is directly concerned with the financial viability of a project or in other words, the rate of return of the capital invested. As far as the word 'financial' is concerned, it is to investigate the stream of costs and benefits in terms of the actual prices involved, i.e. with the market prices. Sometimes a project may involve a number of firms and individuals, where a financial analysis could be done separately for each case. It can also be done in a major public investment project which is, in fact, an evaluation of all items of costs and benefits incurred and achieved in terms of market prices. This will tell us the commercial profitability or the rate of return or the productivity of the invested capital.

All items of costs and benefits may involve everything, including transfer payments like taxes and subsidies. In a financial analysis, taxes are treated simply as costs while subsidies as benefits to the project. Payments like interest charges or in the case of a foreign loan, principal repayments, are treated as costs to the project, and all items of cost may be deducted from the total benefits to arrive at net returns of the project as a whole. In fact, all costs and benefits in terms of their market values are compared to determine whether a project is financially sound or not.

An economic analysis is different from a financial analysis. When a public project involves substantial costs and benefits it is necessary to go into the question of whether or not these values in terms of market prices really represent the economic costs and benefits to society. Since all scarce resources involve opportunity costs, it is important to check whether these market values correctly reflect their true social opportunity costs or not. In this context, wherever market prices seem to be more or less distorted, accounting prices are used instead. The fact is that there are severe distortions in market prices due to governmental controls, subsidies, taxes, etc. Therefore, it is believed that certain market prices fail to reflect their true economic values, and hence cannot be included in an economic analysis. This necessitated the adjustment of certain market prices which may be termed as shadow or accounting prices where these are believed to reflect true social and economic values.

An economic analysis is important from the national standpoint. For example, taxes which are treated as costs in a financial analysis, are treated as transfers and it is not deducted from the overall gross returns. Furthermore, subsidies may be treated as costs, simply because these represent real costs to the society. Therefore, an economic analysis is a further step of a financial analysis which viewed all benefits and costs not only from a financial point of view, but more importantly in terms of their true economic values from the national standpoint.

By contrasting the two analyses it is important to note that a financially sound project which would have the effect of increasing disparities between regions or groups cannot necessarily be called justified from the standpoint of the general interest of the society. Conversely, a project which is less financially profitable, but is designed to open up a poor region and give it a better chance of taking part in the general economic growth of the country may be termed as justified.

Benefits of an irrigation project are, as mentioned earlier, direct benefits and indirect benefits. In principle, calculations of profitability cannot be concerned only with benefits of the first type. Unfortunately, however, indirect benefits are very difficult to measure economically. Any failure to take account of these indirect benefits would lead to an incomplete analysis and would be detached from real situations. Therefore, an economic analysis will have to deal with the following two distinct elements through the use of two alternative criteria, namely the internal rate of return or benefit-cost ratio:

(a) measures of direct profitability;
(b) measurement of indirect benefits which are, for example, the effects of a project on land use planning, social conditions of the people, stimulation on other sectors of production, etc.

The purpose of all this is to ascertain the economic value of a project in terms of the real cost of the various factors of production and the effective value of the discounted net benefits for the whole duration of the entire life of the project.

Benefit-cost analysis is undoubtedly the most used and the most useful form in the economic evaluation of projects. It consists in comparing all benefits of the project with the total additional cost of investment during the life-time of the project. Taking into consideration the time factor, the two flows of benefits and costs are discounted at an appropriate discount factor. It is, in fact, a ratio of the discounted sum of benefits and costs, and if the former is higher than the latter, the project is termed as profitable.* A project for which this ratio is greater than one may, in principle, deserve to be carried out.

The internal rate of return is computed in the same way as the benefit-cost ratio, by discounting the two streams of benefits and costs. The rate of discount at which the difference between the discounted sum of benefits and cost becomes zero is exactly the internal rate of return; which shows the direct return on capital invested. This rate may be compared with bank loans rate needed to carry out the project or the expected rate of growth of the national income.**

In most developing countries, there exists severe distortions in market prices on account of administered prices, taxes, subsidies, etc. Therefore, it is importantly necessary to perform economic analysis of benefits and costs at shadow prices rather than a financial analysis at market prices. It is recognized by leading economists concerned in this respect, that adjustment of market prices are necessary and should be adopted in the evaluation of irrigation projects.*** The analysis of projects in terms of adjusted prices is known as the 'social benefit-cost analysis', which is, in fact, a further step of the conventional benefit-cost analysis with market values.

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* There are several possible discount rates such as the bank rate, the rate of interest on savings, the rate of interest on long-term bonds, or the expected rate of growth of the national economy. The choice of the rate of discount must reflect the social interests and time preference of the economy.

** Useful discussions in this respect are found in 'Economic Analysis of Agricultural Projects', J. Price Gittinger, Johns Hopkins University Press, 1972 and also in 'Guide to the Economic Evaluation of Irrigation Projects', Hellmuth Bergmann, OECD, Paris, 1973.

*** See for example Bhatia and Sinha (1982) among many others.

Social benefit-cost analysis has developed into an effective analytical methodology for project evaluation. In fact, there are two main evaluation procedures which are adopted by policy-makers. They are (a) the UNIDO method+ recommended by the United Nations and associated organizations, and (b) the OECD method suggested by Little and Mirrlees. These two main approaches are widely used in the evaluation of irrigation projects in many developing countries. There is still another method followed by the World Bank known as the Squire-Van der Tak approach. In fact, this is a slight variant of the Little and Mirrlees method.*

Detailed discussions of the two main approaches may be found in a wide range of literature.** The UNIDO method widely discussed the various objectives and the role of public investment in the realization of such objectives. It suggests that all measurements involved in the project evaluation should be valued in terms of present aggregate consumption. According to the Guidelines, market prices are considered inappropriate in the reflection of social benefits and costs. For the true reflection, goods and services are valued in terms of 'shadow prices'. The Guidelines divide the set of shadow prices into two classes. One consists of prices concerned with specific commodities, which depend on the assessment of the project evaluator. The other consists of

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* The literature on social benefit cost analysis is a current subject developed during the last decade. Widely discussed basic texts are UNIDO Guidelines for Project Evaluation (1972), Guide to Practical Project Evaluation (1978), and the OECD Manual by Little and Mirrlees (1968, 1974). Theoretical discussions in depth are also done by Dasgupta and Pearce (1972), Marglin (1967), Mishan (1971), Deepak Lal (1974), and Harberger (1971).

A number of contributions concerned with this literature are also made by Squire-Van der Tak (1972), Bacha and Taylor (1971), A.K. Sen (1968, 1972, 1975), Bruro (1972), Beyer (1975), Adler (1971), Gitteiger (1972), Schohl (1979), and Chopra (1979).

In the field of irrigation economics and economic evaluation of irrigation projects, main contributions are made by Deepak Lal (1972), Krutilla and Eckstein (1958), Major (1969), Rogers and Smith (1970), Smith (1975), Bergmann and Boussard (1976), Bruce and Kimaro (1978), Lenton (1979), and Dhawan (1982).

** See 'Cost-Benefit Analysis', Penguin Modern Economics Readings, edited by Richard Layard and also 'Economic Appraisal of Irrigation Projects in India', Basawar Sinha and Ramesh Bhatia, Institute of Economic Growth, Delhi, 1982. Comparisons of the two approaches can also be found in 'Methods of Project Analysis, A Review' Deepak Lal, Johns Hopkins University Press, 1974, and in 'Shadow Exchange Rates and Standard Conversion Factors in Project Evaluation', Peter Warr, ADB Economic Office Report Series, 1982.

\+ The manual prepared by Dasgupta, Marglin and Sen on behalf of UNIDO is sometimes referred to as UNIDO manual.

parameters concerned with the economy as a whole, which are to be used uniformly in all projects. The latter class, which consists of such prices like price of unskilled labour and value of foreign exchange, are among the national parameters. These parameters consist of a variety of national weights reflected by various goals of the government.

The approach to social benefit-cost analysis presented in the Guidelines consists in attempting to measure the impact of the project on the economy. The net output or the value of benefits is measured by the willingness to pay by the consumer. If this adds to exports or substitutes for imports, the Guidelines procedure is to estimate the impact of the foreign exchange. Assumptions are made in the foreign exchange market, which imply that the value of foreign exchange is worth more than its nominal value. Benefits and costs of foreign exchange are converted by a shadow price of foreign exchange into units of aggregate consumption expressed in terms of domestic currency.

On the other hand, if an input is drawn from an alternative use which results in a decline available to the rest of the economy, it may be measured in terms of benefits foregone in alternative uses. If it is not the case, then it is to be measured by the resource cost of increased production. If an input is imported or exported, the cost is measured by the sacrifice in foreign exchange involved or earned, later converted into shadow values by means of the shadow price of foreign exchange.

The UNIDO is not only concerned with the efficiency of the use of resources, it is also concerned with the inequities of income distribution that prevails in most developing countries. A major contribution of the Guidelines in the literature of economic evaluation of projects is its emphasis on investment decisions that stimulates the growth of the national economy.

The Little-Mirrlees method, on the other hand, divides the project components into three categories. They are:

(a) traded goods and services which can be exported or imported;

(b) non-traded goods and services; and,

(c) unskilled labour.

The Little-Mirrlees method suggests that if some of the demand for a commodity is satisfied from imports or some of the supply is exported, it is termed as a traded good. Other goods and services which do not fall under this category, are referred to as non-traded. The general rule is that the accounting price for an imported good is the total foreign exchange cost including any increase in the cost of existing purchases of increasing imports by one unit. In other words, the shadow price for an imported good is its marginal import cost. If an exported good is sold at a fixed border price in terms of foreign exchange excluding taxes, subsidies, etc., that price is regarded as the accounting price. The general rule for an exported good is that the accounting price is equal to the marginal export value. The OECD method is more appropriate for an open economy, where it uses world prices in valuation of goods and services. This is one of the most distinguishing features of this method.

In the case of non-traded goods, the marginal social cost and the marginal social benefit are considered in defining the accounting price. The marginal social cost is the value of the resources required to produce an extra unit of the commodity, in terms of accounting prices. The marginal social benefit is the benefit in terms of social values, derived from supplying to the economy an extra unit of the commodity. To find the accounting price of a non-traded input, it is necessary to estimate the proportions in which extra demand for a unit of the commodity will increase production and reduce consumption elsewhere. Then the accounting price will take into account both the marginal social cost and the marginal social benefit. For a non-traded good like unskilled labour, its shadow price or the shadow wage rate depends upon its opportunity cost, the industrial wage rate, and the shadow price of investment, which is a national paramenter.*

In both methods, shadow prices are used to evaluate unskilled labour, foreign exchange or other traded and non-traded goods. Over the estimated entire life of a project, benefits and costs are valued not only in terms of market prices but more importantly with shadow prices which are later discounted back to the present period by using an appropriate social rate of discount.

In fact, both methods were developed primarily for evaluation of

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* For detailed discussions of the OECD method, see 'Project Appraisal and Planning for Developing Countries', I.M.D. Little and J.A.Mirrlees, 1974.

industrial projects, but both could also serve as basic methodologies in the evaluation of irrigation projects. Although the two methods differ on the use of numeraire, (UNIDO uses 'Consumption Units' while OECD uses 'Foreign Exchange Units') they are basically similar.

Firstly, both methods realize the fact that market prices are more or less distorted. Thus, both of them recommended the use of shadow prices for the appropriate measurement of social benefits and costs. Secondly, both considered the net present value as the best criterion for economic judgements.

On the other hand, there are also differences. The numeraire for UNIDO procedures is aggregate consumption and all benefits and costs are measured in terms of domestic prices while the numeraire for OECD procedures is savings, and benefits and costs are measured in terms of foreign border prices.

In both approaches, traded goods play an important role in determining the evaluation of a project. The UNIDO considered it is important to estimate the foreign exchange inflows and outflows and the same are valued with border prices, along with the shadow price of foreign exchange. As mentioned before, in the case of traded goods, the OECD regarded the marginal import costs as the shadow price of import and the marginal export revenue as the shadow price of export.

The main differences can be expressed in terms of differences in judgements of economic constraints and the role in which planning agencies play in influencing economic policies, especially those of trade and tariff policies. In this respect, the UNIDO seems to be more realistic in assuming that in many developing countries there are severe distoritions in prices and other economic activities. It also argued that a planner or a project evaluator may not be in a position to control or remove severe distortions or other restrictions. In this concern, the Little-Mirrlees method assumes that the project evaluator is in a position to suggest changes in the policies and restrictions.

In an evaluation of an irrigation project or any other kind of project, the appropriate method to be used would depend crucially on the nature of the restrictions in the economy and the capability of the planner in a position to adjust policies and restrictions. In most developing countries where market prices are more or less distorted and where administered prices play an important role in the economies, the UNIDO is likely to be a more realistic and appropriate one. The UNIDO Guidelines has set up five stages in project appraisals, namely,

(a) Calculation of financial profitability at market prices where it describes the discounted cash flow analysis of the rate of return on the resources involved in the project over its lifetime when all inputs and outputs are valued at market prices;

(b) Shadow pricing of resources to obtain the net benefit at economic prices, where the market prices are replaced by shadow prices based on opportunity costs or economic prices;

(c) Adjustment for the project's impact on savings and investment, where the net effect of the project on total savings and investment is quantified and revalued by the shadow price of investment;

(d) Adjustment for the project's impact on income distribution, where the income flows arising from the project are identified and income weights or shadow prices are placed on the incomes going to different groups;

(e) Adjustment for the project's production or use of goods such as luxury consumer goods and basic needs where social values are less than or greater than their economic values.

In the first stage, a financial analysis using market prices should be done beforehand, i.e. before an economic evaluation is made. Since market prices are believed to be distorted, an economic benefit-cost analysis is usually done in a social context where benefits and costs are assigned their efficiency shadow prices. The necessary shadow prices could be derived from a mathematical model or an input-output model of the economy. Major resources where there is a need for shadow pricing are:

(1) main outputs which are often sold at fixed prices;

(2) importable inputs which may be domestically produced or may be imported at high substantial protection rates;

(3) major non-imported material inputs; and,

(4) unskilled labour.

The UNIDO uses aggregate consumption units in terms of domestic currency as the numeraire. The major difference between the two approaches in principle is the difference in numeraires. The UNIDO uses present consumption as the numeraire and put a premium on savings while as the Little-Mirrlees method uses current savings as the numeraire and penalizes consumption.

For the UNIDO approach, the foreign exchange impact of the project must be identified in such a way that the net present value may be adjusted by an appropriate premium, assuming that foreign exchange is more valuable than indicated by the official exchange rate. This procedure will increase those values measured in border prices by the percentage premium on foreign exchange, which roughly indicates the level of protection in the economy. The premium to be attached to foreign exchange is important. The UNIDO uses a foreign exchange shadow price based on marginal social values as revealed by the consumer's willingness to pay in the form of imported goods.

One of the most common distortions in the literature of economic evaluation of projects is in the labour markets of labour surplus economies. The distortion is such that the wage rate does not equal the social opportunity cost of labour in the economy. There are two distinct components identified in the social opportunity cost of labour in labour surplus situations. The first is the output foregone elsewhere in the economy, as a result of employing labour in the project. The second is the cost in terms of increased aggregate consumption as a result of more labour employed by the project. It is assumed that labour consumes most of its income. If present consumption is socially less valuable than current savings, any increase in aggregate consumption will not be as valuable as the equivalent amount of savings. This factor will be reflected in the measurement of the social opportunity cost of labour.*

If labour is drawn from alternative employment, the shadow price or the shadow wage rate will be the willingness of other users to pay for this labour. If labour is newly employed, the shadow wage rate is normally zero, since the society gives up nothing to gain an additional unit of labour.*

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* Numerical examples could be found in 'Methods of Project Analysis, A Review', Deepak Lal, Johns Hopkins University Press, Baltimore and London.

The UNIDO suggests that for a social benefit-cost analysis of an irrigation project, the project evaluator would need the national parameters, namely:

(a) social rate of discount;
(b) shadow price of investment;
(c) shadow price of labour;
(d) shadow price of foreign exchange; and,
(e) income distribution weights.

These parameters include the relative weights on the relevant objectives of economic development. They are, in general, independent of decisions taken at the project level. The calculation is assigned to the national level of the planning process.

These national parameters could be derived from a national plan, where they are set by those at the top-level planning process. In this way, national parameters involve value judgements in an explicit, quantitative fashion. Because they are simply quantifications of value judgements such as weights on objectives and the social rate of discount, they are treated as unknowns of the problem of project formulation and evaluation. These parameters whose magnitudes depend also on observable factors of economic development such as shadow price of investment and the shadow wage rate may be treated as functions of the unknown weights.

Therefore, the derivation of these parameters are the responsibility of those involved in the central planning organizations. For the derivation of the social rate of discount, it is assumed that benefits and costs which occur in the future are less valuable than present benefits and costs, where per capita consumption is expected to rise in the future. The appropriate measure of the aggregate consumption attributable to investment is a weighted sum of present and future benefits and costs of a project. The parameter which is used to discount the benefits or cost stream to the present is the social rate of discount.

Similarly, a shadow price of investment could also be derived at the national level. The shadow price or the social value of investment is, in fact, the net present value of the aggregate consumption stream resulting directly and indirectly from a unit of marginal investment. In a single model where there is no reinvestment of benefits and where there are only direct benefits considered, the shadow price of investment depends on capital productivity and the social rate of return. In a more realistic model, a re-investment of benefits and the indirect effects must be taken into account. In this sense, the shadow price of investment is also determined by the marginal propensity to save.*

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* Theoretical aspects of the UNIDO, including the derivation of the national parameters, are discussed in depth in 'Guidelines for Project Evaluation', Project Formulation and Evaluation Series, No. 2, United Nations, 1972.

CHAPTER 4

PROJECT WORKS AND WATER MANAGEMENT OF THE KYET-MAUK-TAUNG IRRIGATION PROJECT

4.1 General Description

Kyet-mauk-taung project lies in the arid zones of central Burma, in Kyaukpadaung township. The arid zone of central Burma is widely known as the Dry Zone Area, because of its scarcity of rainfall and water and also because of high temperate climates. Similar to other regions in the Dry Zone, Kyaukpadaung township in which the project lies has an annual average rainfall of 32.47 inches, which is insufficient to raise agricultural crops. Available slight rainfall there is mainly because of the famous volcano, Mt. Popa, which has a height of more than 4981 feet above sea level.

Serving like an oasis in the middle of a big semi-desert, Mt. Popa is one of the most beautiful natural scenery in the Dry Zone. From a bird's eye view, one can see streams and streamlets flowing down and around Mt. Popa. These streams have little or no water during the hot season, but in the rainy season the streams have full water flows, causing damage to villages, roads, bridges and even human lives. As there was no control over these water flows, little or no water was left for the farmers to grow any crops in the dry season.

The local inhabitants were extremely poor. Their main source of income was from jaggery made from palm trees, and to make situations worse, this one and only means of living caused deforestation in the area. Gradually, after many years, the climatic conditions changed as a sequence and the area was transformed into a semi-desert. That alarming situation had caused much anxiety to the government. It had been obvious for quite some time that serious actions were necessary to prevent deforestation and soil erosion in that area.

The government, realizing that the area could easily turn into a desert, prohibited the local people cutting any trees or bushes. With increased deforestation and soil erosion as the years went by, the local people were deprived of their customary source of income from making jaggery. Having no other facilities, the local people were confronted with difficulties of finding an alternative means of living. Agriculture was impossible for nature's endowment of water supply was very precarious and insufficient even for domestic purposes.

There were no irrigation facilities in the area. The existence of two rivers in Kyaukpadaung town, i.e. the Taungzin and Kyaukpon Rivers were regarded as a potential source of irrigation. The waters of these two rivers ran into waste and were not tapped for agricultural use to any great extent.

The water flows in the two rivers were irregular, due to very little rainfall in the upper catchments. Water for agricultural use could only be made available by means of a storage system. It was then that the government decided to build a dam across the two rivers, just above their confluence to form a storage reservoir.

With stored water supply, it was expected that two good crops of diversified cultivation could be grown annually. It was anticipated that double cropping could be possible on 30,000 acres where cotton, groundnut, maize, sesamum, pastures, orchards and vegetables could be grown making a total gross cropped area of 52,000 acres. It was hoped that it would greatly improve the economy of the area as well as provide a means of living for the local people and thereby enhance their standard of living.

Kyet-mauk-taung dam is an artificial lake having a water spread area of about 1800 acres and maximum depth of 97 feet. It encourages the growth of vegetation and afforestation in the vicinity. This, in turn, attracts rainfall which assists a great deal in soil conservation. The reservoir assures adequate domestic water supply for those villages in the vicinity where the water problem is acute.

The two rivers, the Taungzin with 52.24 square miles and the Kyaukpon with 86.74 square miles of catchments are the main feeders of the reservoir. Catchments of both the rivers are located on the slopes of the extinct volcano, Mt. Popa, which is characterized by steep gradients.

Gauging observations on both rivers had been made since 1955. Mean co-efficient of run-off as determined from these observations was 0.35, which cannot be considered as too high in view of the high slopiness of the catchments. Run-off of both rivers was determined by studying precipitation data from 1901 to 1940; a period of 40 years. The yearly flow of both rivers is very erratic, the flow being 39.8 thousand acre-feet in 1907 and 195 thousand acre-feet in 1908. The mean flow of both rivers for 40 years was 97 thousand acre-feet.

The reservoir is designed to have a full tank capacity of 73,100 acre-feet, allowing 3,100 acre-feet of dead storage. This is the most convenient height for release of water from the reservoir into the main canals and the maximum utilization of the reservoir capacity. Investigations on sediment were not made. The two rivers carry a fair amount of sediment.

4.2 Historical Background

It was in 1929 when the colonial British Government first intended to build a dam across the two rivers. The main intention of the British was that by constructing a reservoir, government revenue could be gained by taxing the farmers and by fixing water charges. The British projected that farm taxes and water charges would not only cover the cost, but in future would also bring long-term revenue. The idea was, however, abandoned.

In 1952, the Burmese Government made plans for reforestation along with control and maintenance of the natural vegetation in the Mt. Popa area. A design for an irrigation dam was made, and the possible location for the dam site was foremostly surveyed by real Israeli experts who later reported that a dam could be constructed irrigating an area of more than 30,000 acres. Further, in 1953 geological and engineering surveys were made by the Irrigation Department. By 1957, the Agricultural Rural Development Corporation with technical aid from Soviet experts, finished detailed surveys and finalized project designs.

The main objective was to fully utilize the water flows of the two rivers, for irrigation and agricultural purposes and domestic water consumption. The government also intended to redistribute the lands that were to be cultivated with irrigation water, thus leading to fair distribution of irrigated lands and also the enhancement of socio-economic conditions.

After all the necessary surveys and designs were made, the initial construction works started in 1961. In 1962, a mission was sent to the Soviet Union, for the government desired to have the project implemented more quickly and also to request financial aid. Though the delegation requested an outright gift of the foreign exchange component of the project, it was only possible to obtain a credit of 3.5 million roubles. It was agreed that the credit would be repayable in a 12-year period at an interest rate of 2.5 per cent, and the repayment was to commence one year after completion of the project. It was also agreed with the Soviets, that the project would be completed by the end of 1965.

A draft was drawn in which the credit amounting to Kyats 192.31 lakhs was to be utilized as follows:

	Million Roubles	Kyats (Lakhs)
1. Equipment	1.40	76.92
2. Materials	1.64	90.11
3. Russian experts	0.33	20.88
4. Design of canal systems	0.68	4.40
	3.50	192.31

An agreement was also made for the employment of 18 Russian experts and five interpretors. After the mission had returned to Burma, the agreement the credit for equipment, materials, Russian experts, and design of canal system was accepted, but the number of experts was later agreed to be reduced.

Further, it was considered not to rush the project but to phase it for completion within five years. A financial plan was drawn for annual expenditures of total local and foreign exchange requirement for the implementation of the project and the purchase of mechanical equipment.

4.3 Geological and Hydrogeological Factors

Kyet-mauk-taung dam site lies at 25°15' East longitude and 20°48' North latitude at a distance of eight miles south of the extinct volcano, Mt. Popa. Mt. Popa region geologically forms the largest and southernmost of the group of Lower Chindwin volcanos which were active in tertiary and late tertiary period.*

Southeast of Mt. Popa in the region of Kyet-mauk-taung, there are ridges of low hills composed of andesite and associated tuffs which by geological structure of terrain are older than the rocks of Mt. Popa. It is stated in geological literature that formerly it had been a separate region of volcanic activity.

The foundation of the damwas made up of various alluvial deposits, sands, loams and sandy loams. The location of the dam site seemed to be the only available site for the meeting of the two rivers and there were no alternative sites available in the locality.

Observations made on dam site and along dam axis failed to reveal any tectonic shifts, dislocations, displacements and extensive jointing of rocks. Dislocation of bedrocks on dam site was slight and showed

* The tertiary period in Geology literature is the third period in the formation of rocks.

various degrees of jointing and weathering mainly in upper layers. These joints of rocks were filled with secondary formations. Thus the dam site was found to be acceptable for construction of an earthen dam. On the dam site section west of Taungzin river, there were bedrocks which could serve as a reliable foundation for the dam. Seismicity of the region was investigated to a very small extent. Information obtained from the Geological Department of Burma showed that the region has a magnitude of earthquate intensity (eight) by Rossi-Farrel scale. Geologically, the reservoir basin is composed of volcanic detrital and alluviam soil made up of sand-clay and also erupted rocks.

Kyet-mauk-taung area is very dry, having an average annual rainfall less than 33 inches. Because of little rain, the temperature is also very high with 33.9°C as maximum and 21.3°C as minimum, and annual humidity is recorded as 67 per cent. The Dry Zone area of Burma has the highest temperature. Although it is in the middle of the Dry Zone, Kyet-mauk-taung area has a fairly cool climate in hot seasons because of Mt. Popa. The area has also a relatively higher annual rainfall compared with neighbouring areas.

Catchments of the two rivers are heavily cut and dismembered by modern hydrographic network having a typical mountainous character with short periods of water flow. The two rivers, which are fed by their numerous tributaries and being mostly deep for ground waters due to ground water feeding, carried inconsiderable flow almost all year round. But in some dry years the surface water flows become completely nil, and the rivers carry a very small underground water flow. During the hydrogeological surveying periods, geological and hydrogeological characteristics showed the hydro-centre site as very complicated, though suitable for creation of a reservoir. Before the construction period began, it was reported that the selected site was feasible and sound, both from engineering and geological points of view.

4.4 Construction of the Project

The construction of Kyet-mauk-taung project started in 1961-62. It was planned that after completion there would be two irrigation systems, i.e. the right and the left canal systems, and eight villages on the left canal system and eleven villages on the right canal would have an irrigable area of 9,752 acres and 18,335 acres respectively.

By 1961-62, when all the necessary geological and engineering surveys were completed, the construction of the project started in earnest. The construction of the whole dam was divided into parts, and in the first initial year, part of the dam with 1,270 feet in length and nine feet in height was completed.

In 1962-63, the second year of construction, a second part of the dam with 2,450 feet in length and 44.3 feet in height was planned to be completed; but due to some failures, the dam reached only 27 feet in height. Base clearing of the dam was also made in that year along with the concreting of the reservoir outlet.

A twelve-member team of Soviet experts arrived in 1963, in accordance with the technical aid agreement. By 1963-64 the second part of the dam was completed and also the construction of the two canal systems started. The reservoir outlet was completed in 1964. A coffer dam was built on Taungzin River and as a result there appeared a water storage area with 30 feet in height and 20 feet in depth. Soviet mechanical equipment, which was part of the technical aid, arrived in 1964.

In 1964-65, construction works such as excavation for reservoir outlet with tower and outlet into the left canal, concreting of reservoir outlet tower, concreting of stilling pool with outlet into the left canal were completed. In the same year, the gate for the water flow was installed, and also the earth filling on the Taungzin River reached a height of 55 feet. Further, a coffer dam was built on Kyaukpon River with a height of 48 feet.

The years 1965-66 and 1966-67 were the final years of construction. To complete the project on schedule, manpower, material and equipment were used in full strength during the final years.

The main construction work was the erection of an earthen dam. An escape for excess water, an aqueduct, a bridge and a canal from stilling pool to aqueduct were also constructed. The construction period was from 1961-62 to 1966-67. The project was completely constructed in June, 1967. In building this project, 146 civil engineers, 10 mechanical engineers, 43 mechanics, 315 machine drivers and workers, and a total of 2704 masonry workers, carpenters and manual labourers were involved.

4.5 Some Salient Features of the Dam

The dam is situated above the conjunction of two rivers, the Kyaukpon and Taungzin. The dam is a rolled earth-filled one, having a maximum height of 112.5 feet at the deepest section and a total length of 8,500 feet. It has a crest width of 32 feet.

The reservoir outlet discharge was calculated to provide one cubic foot per second of water per 57 acres of irrigated area. This amount allows a coefficient of efficiency of the irrigation system of 0.55 to give an average of 2 inches of water to 30,000 acres of cropped area every 10 days.

The escape is built to discharge 48,000 cusecs. As it is expected that this escape will function to full capacity perhaps once in 200 years, it has been very cheaply constructed and no elaborate and costly protective works have been made.

Statistics of the dam are given below:

1. Catchment area	
(a) Taungzin River - 52.24 sq. miles	
(b) Kyaukpon River - 86.74 sq. miles	138.98 sq. miles
2. Average annual discharge runoff	97,000 acre feet
3. Dead storage	3,100 acre feet
4. Effective storage	70,000 acre feet
5. Capacity at full tank level	73,000 acre feet
6. Water spread at full tank level	1,800 acres
7. Crest level of dam from mean sea level	950.5 feet
9. Maximum height of dam	112.5 feet
10. Crest width of dam	32.0 feet
11. Number of dams	3 dams
12. Length of dam	8,500 feet
13. Type of dam	homogenous earth filled
14. Type of spillway	flush type
15. Length of spillway	1,580 feet
16. Discharge capacity	48,000 cusecs
17. Length of reinforced pipe	434 feet
18. Discharge capacity	520 cusecs
19. Height of control tower	80 feet
20. Gate	radial gate (hydraulic)

4.6 Water Management and Distribution Systems

The irrigation system of Kyet-mauk-taung is mainly in two categories, i.e. direct canal system with suitable structures and drainage where necessary and contour canal system with less structures.

The irrigation network is divided into the left side and the right side canal. The left and right canal systems have a length of 7.0 miles and 12.00 miles respectively. Also there are distributaries, minors, field channels and other irrigation structures on both the systems. On the farms, the farmers are instructed to dig their own field channels in such a way that irrigation water can reach their fields systematically without much water loss.

The discharge capacity of the left canal is 182 cusecs while the longer right main canal has a higher discharge capacity of 384 cusecs. With this, the left and right canal systems have an irrigable area of 9,010 acres and 20,776 acres respectively.

At places where the minors and distributaries divert from the left and right main canals, watch-houses are built to supervise the flow of water. These serve as water gauge stations. There are also head regulators, checks, crossings, outlets, drainages, super passages, inverted syphons and aqueducts built on both the systems.

Statistics of the distribution system are:

1. Name of Canal

Name of Canal	No.	Left System Mile	Left System Kilo	No.	Right System Mile	Right System Kilo
(a) Main canal	1	7.0	11.26	1	12.0	19.30
(b) Distributaries	5	11.19	18.02	4	28.25	45.53
(c) Minors	8	12.20	19.62	18	20.26	32.66
(d) Field channels	176	40.42	65.00	123	109.57	176.35
(e) Structures	125			205		

2. Discharge capacity:

Left main canal	182 cusecs
Right main canal	384 cusecs

3. Irrigable area:

Left system	9010 acres (3646 hectares)
Right system	20776 acres (8404 hectares)
Total	29786 acres

Irrigation water from the canals have been used both for irrigation and domestic use. Within the irrigable area there are eight villages lying on the left canal system and eleven villages on the right canal system. Altogether there are nine villages which had been removed from the catchment area. Places for resettlement and rehabilitation of these villages had been planned long before the construction of the dam.

These villages have been greatly benefitted from the two irrigation systems. Outside the villages and near the main canals, there are ponds dug by the villagers themselves, where waters from the canals flow into these ponds through concrete water courses. This use of water for domestic purposes is strictly controlled by the authorities. The whole irrigation network has the following account of structures:

No.	Name of Structure	Right Canal	Left Canal
1.	Head regulator	19	10
2.	Check	121	61
3.	Outlet (emergency)	1	1
4.	Drainage	47	39
5.	Super passage	1	1
6.	Inverted syphons	10	2
7.	Aqueduct	4	-
8.	Railway crossing	1	1

As for water management, there is one executive engineer whose responsibility it is to take full charge and authoritative control over the whole irrigation system. A water distribution committee is formed in the Township People's Council,* where the executive engineer acts as secretary. Two assistant engineers, one each for the left and right canal system, served under the administrative body headed by the executive engineer. Their duties are water management, control and maintenance of the two canals. To enable canal inspections more conveniently, motor roads are built alongside the two main canals.

Maintenance of the irrigation canals is one of the most important works for an irrigation engineer. Maintenance of the two canals is performed by two groups, i.e. the maintenance group numbering about 82 people whose duties are to perform all maintenance works the year round and another group known as the 'wet weather gang' with the same number of people who perform maintenance works only during the rainy season.

Maintenance works are mostly the berm-cutting of the canals, clearing of canal beds, and also maintenance of all irrigation structures. These works are generally divided into special repairs and ordinary repairs. Most of the canal berms are often damaged by water flows and it is most important that these damages be repaired annually.

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* The Burmese system has Township People's Council formed in every township for administrative and political purposes.

4.7 The Present Status of the Project

The present status of the project area, contrasting with the pre-project conditions, represents a completely different picture. It must be said that there existed hardly any agriculture before the project. Today, with sufficient water supply available from the storage dam, an intensive cropping pattern which involves cotton, rice, groundnut and sesamum is developed within the irrigated area.

Out of a total irrigable area of 50,000 acres, the net irrigated area is about 46,000 acres. Throughout the agricultural years from 1968 to the present day, the matured acreage on an average basis is no more than 80 per cent of the total sown area. This failure of not achieving the full limits of irrigation is not due to any techno-problems or water management problems of the project. Part of the responsibility lies on some of the farmers who, for various reasons, are not in a position to accept any planned cropping pattern laid by the government.

In the project area, a collective management body is formed for the purpose of water management, whose duties are to supervise the distribution of irrigation water and to exercise control over areas where planned crops are sown. On the other hand, the government has also introduced state and co-operative farms and though it was done on a trial basis which represents a small-scale, it has proved to be successful.

CHAPTER 5

MEASUREMENT OF PROJECT COSTS AND TECHNICAL ASPECTS OF THE PROJECT

It is a well-known fact, and not necessarily to the discredit of those who are in charge of the project, that cost estimates often diverge from actual costs. What is important is to find out where actual costs diverge from estimated costs and the reasons for the divergence in order that better estimates may be made in the future. Hence, in what follows an account of the derivation of estimated costs will first be given, and then they will be compared with the actual costs incurred.

5.1 Estimated Costs

Detailed estimated costs were calculated, based upon detailed designs and drawings of the various structures required particularly for the dam and its ancilliary works. The required number of machine shifts, material and labour were ascertained and thus details of cost estimates of machine shifts, abstract of quantities and costs were calculated. It was at first seen that the total estimated cost of the dam and its appurtenant structures worked out to be Ks 24.3 millions.*

A basic core of essential data estimated at the project level is presented in Table 5.1 given below. Costs for the dam construction was fairly accurately estimated, while that of other costs, especially costs for the irrigation canal network could only be considered as very crude estimates. The costs for foreign experts were considered necessary, and it was already expressed in the original plan to employ a few key experts such as engineering geologists, designing engineers and soil experts. All estimated costs were calculated only after the necessary negotiation with the Soviet Union were made. The elements of total estimated costs are presented in the following table.

* During the early 1960s the official exchange rate was that one U.S. dollar was equal to 5.0 Kyats. The exchange rate with the Russian rouble was also equally close. The cost estimate includes the foreign cost component converted into domestic currency

TABLE 5.1

Estimated Costs of the Project

		Kyats (lakhs)
1.	Earthen dam with protective works	130.0
2.	Spillway	63.0
3.	Conduit and outlet structures	9.0
4.	Miscellaneous (bridges, construction camp, aqueducts, etc.)	41.0
	Total cost for dam	243.0
5.	Foreign experts	12.0
6.	Design and estimating of irrigation canal system	4.0
7.	Construction of irrigation canal system	45.0
	Total cost for the entire Project	304.0

Source: Irrigation Department Headquarters, Rangoon.

The above data have been compiled and presented in an easy format. It represents the costs of construction of the project works, though not divided to year and input, but summed over all the elements of the works. The above was estimated only when the Soviet loan and the investment funds which were to be borne by the Ministry of Agriculture were approved.

Besides the entire cost estimate, depreciation costs for the machines utilized were estimated at about Ks 25 lakhs. Machines and equipment, as well as construction materials of various kinds, accounted for a large part of the estimated cost of investment on both the storage and the regulation of water. Before the construction of the project, the Irrigation Department already had many of its own heavy earthmoving equipment; and these machines were planned to be utilized in the project. Some specialized and additional equipment, however, costing about Ks 69 lakhs in foreign exchange and clearance, etc., were required to be procured. As this equipment could also be used in other later projects, and as costs of depreciation had already been provided for in the cost estimate of the project, it was suggested that the expenditure on equipment should not be charged against the project.

Out of the 3.5 million roubles credit given by the USSR, an agreement was made that 1.4 million roubles would be spent on purchasing equipment, and 1.64 million roubles on materials. It was also agreed that all equipment and material purchased for the project would be Soviet made.

For the whole project, taking into consideration only actual operational costs, the estimated cost of Ks 304 lakhs was even planned to be reduced to Ks 279 lakhs. This was supposed to be the early estimation of costs. As the project was planned to be finished within five years, a general plan of annual expenditure of total local and foreign exchange requirement for the implementation of the project and the purchase of equipment was estimated as below:

TABLE 5.2

Annual Expenditure of Total Local and Foreign Exchange Requirements

Particulars	1st Year		2nd Year		3rd Year		4th Year		5th Year	
	F.E.	Local	F.E.	Local	F.E.	Local	F.E.	Local	F.E.	Local
1. Dams and Canals	1.5	11.9	25.8	36.1	32.2	49.5	25.0	54.0	18.0	38.0
2. Foreign Staff	-	-	4.0	2.7	4.0	2.7	4.0	2.7	-	-
3. Local Staff	-	3.54	-	3.54	-	3.54	-	3.54	-	3.54
4. Equipment	1.5	0.5	75.5	12.5	-	-	-	-	-	-
Total	3.0	15.94	105.3	54.84	36.2	55.84	29.0	60.14	18.0	41.54

The above data is recompiled and presented in a more convenient format as follows:

	F.E.	Local	Total
1. Dams and Canals	102.5	189.5	292.0
2. Foreign Staff	12.0	8.0	20.0
3. Local Staff	-	17.7	17.7
4. Equipment	77.0	18.0	90.0
Total	191.5	228.2	419.7

Source: Irrigation Department Headquarters, Rangoon.

* Rouble costs were converted into local currency (Kyats) at the exchange rate of Ks 5.29 = 1 rouble.

This was actually the second estimate of the entire project costs. Obviously, it will be seen that the above estimates exceeded the initial estimate of Ks 304.0 lakhs by Ks 115 lakhs. However, a closer examination reveals that this difference is largely due to the inclusion of local costs for foreign staff and equipment of 8 lakhs and 90 lakhs respectively, in the latter estimate. Estimated details of additional equipment required were as follows:

TABLE 5.3

Estimated Cost of Additional Equipment

	Particulars	Quantity (c.i.f.)	Estimated Cost (Ks. lakhs)
1.	Excavators (1.3 cu. yds.)	7	14.56
2.	Bulldozers (80 h.p.)	6	3.96
3.	Tractors (80 h.p.)	4	2.64
4.	Motor rollers (10 T)	5	1.46
5.	Compressors (8 cu. yds./min.)	10	1.67
6.	Tippers (5 Ton)	70	22.96
7.	Tippers (2.5 Ton)	20	2.56
8.	Auto-cranes (3 Ton)	2	0.83
9.	Sheep foot rollers	4	0.08
10.	Looseness of soils	1	0.02
11.	Tankers (bowsers) (4.5 Ton)	5	1.24
12.	Stone crushers with screw	1	0.82
13.	Cement gun	1	0.06
14.	Pneumatic Tampers	1	0.001
15.	Perforators	12	0.07
16.	Pneumatic Tools	130	0.35
17.	Jeeps	20	1.89
18.	Trucks (5 Ton)	10	3.00
19.	Trucks (2.5 Tons)	5	0.57
20.	Diesel Bowsers	2	0.50
21.	Pump 6" diameter (diesel)	4	0.24
22.	Pump 2" diameter (")	4	0.08
23.	Cost of workshop equipment	1	8.00
24.	Low bed trailers (40 Tons)	2	1.00
	Total Estimate		68.65
	Customs duty, clearance etc.		11.00
	Total estimate		79.65

Source: Irrigation Department Headquarters, Rangoon.

Concerning the economic and technical assistance to be rendered by the USSR to the Union of Burma in the construction of the project, the Government of Burma and the Soviet Union guided by a sincere desire to promote friendly relations and mutually advantageous co-operation between the two countries, and in pursuance of the request of the Government of Burma, concluded a protocol made on 30 August, 1962. (The articles are given in Appendix A).

As already mentioned in the Protocol, interest payments were to be made in the first quarter of the year following the year for which it was accrued. The Burmese Government made the necessary calculations of interest payments a year ahead of the due date, in order to be able to pay in the first quarter of the coming year. The yearly principal repayments and interest charges from 1968 to 1979 are shown below (Table 5.4).

5.2 Actual Costs

The project involves directly two separate branches of costs; namely, the capital costs incurred by the Ministry of Agriculture and the Soviet loan. The Ministry incurred about 65 per cent of the total expenditure in connection with the construction of the project. It also incurred the cost of operation of the project plus costs of farm equipment, agricultural credit and extension services made available to farmers in the irrigated tract.

The Soviet loan which accounted for 35 per cent of the total cost was to finance the capital costs of the project. This foreign exchange component of the investment amounts to 3.5 million roubles or Ks 191.5 lakhs in terms of domestic currency. As already mentioned before, the Soviet loan was to be repaid over a twelve year period following completion of the project works, with an effective rate of interest of 2½ per cent on the due balance. In fact, there was no grant for a period of grace even during the time of construction where interest rates were already charged.

The total construction costs which included the two separate branches of costs amounted to Ks 570.88 lakhs. A break-down of total costs is shown in Table 5.5.

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* It was learnt that the principal repayments and interest charges were made in terms of U.S. dollars, although it was agreed to be repaid in terms of roubles according to the original protocol. Charges of banks for repayments were made for convenience sake in the interest of the two parties.

TABLE 5.4

Principal Repayments and Interest Charges

From 1968 to 1979

Year	Principal Repayment	Interest
1968	Roubles 291056.56 = Ks.1539980.00	Roubles 87294.05 = Ks. 461880.00
1969	Roubles 291056.00 = Ks. 1534980.00	Roubles 81616.96 = Ks. 431840.00
1970	Roubles 291056.00 = Ks. 1539980	Roubles 73107.61 = Ks. 386820
1971	Roubles 291056.00 = Ks. 1539980	Roubles 65952.48 = Ks. 348960
1972	Roubles 291056.00 = Ks. 1878020	Roubles 58231.41 = Ks. 375740
1973	Roubles 291056.00 + Ks. 1878020	Roubles 51056.08 - Ks. 329440
1973	Roubles 291056.00 = Ks. 1878020	Roubles 43739.25 - Ks. 282230
1975	Roubles 291056.00 = Ks. 1877880	Roubles 36422.43 - Ks. 307170
1976	Roubles 291056.00 = Ks. 2630950	Roubles 29105.60 - Ks. 268000
1977	Roubles 291056.00 = Ks. 2655090	Roubles 21808.99 = Ks. 199310
1978	Roubles 291056.00 = Ks. 2809370	Roubles 14512.38 = Ks. 148550
1979	Roubles 291056.00 = Ks. 2865060	Roubles 7215.76 = Ks. 71030
Total	Kyats 24,632,330	Kyats 3,610,970

TABLE 5.5

Break-down of Total Construction Costs

Works	Costs (lakhs)
1. Earthen dam	223.58
2. Canal systems	98.90
3. Roads	20.0
4. Foreign experts	8.81
5. Machines and equipment	185.19
6. Custom duties for machines and equipment	34.40
Total costs	570.88

Source: Irrigation Department Headquarters, Rangoon.

The main costs were for the construction of the earthen dam with protective works, and for machines and heavy equipment imported from the Soviet Union. Also the construction of a network of canals consisted of a major portion of the total costs. The network was largely built around the two main canals, which took off from the dam. The supply of water to the fields was further spread through distributaries and minors. The total cost for the network includes the costs for design, construction and the lining of all canals. This entire cost of the system for the distribution of water for irrigation worked out to 18 per cent of the total capital investment.

The actual total cost for the entire project of Ks 570.88 lakhs was in excess of the estimated total cost of Ks 419.70 lakhs by Ks 151.18 lakhs. It will obviously be seen that this was mainly due to an increase in the cost of machines and equipment. It is also necessary to distinguish between imported and domestically supplied machinery and also between different types of labour. The excess over the estimated cost was due not only to imported machinery but also to imported labour.

A break-down of annual costs during the construction periods, the original estimate and the difference between them is shown below in Table 5.6.

TABLE 5.6

Break-down of Annual Costs and Estimated Costs During Construction Periods

	Year	Costs (lakhs)		
		Actual	Estimates	Difference
1.	1961-62	11.89	18.94	- 7.05
2.	1962-63	25.29	159.84	-134.55
3.	1963-64	43.48	92.04	- 48.56
4.	1964-65	85.92	89.14	- 3.22
5.	1965-66	290.61	59.54	+231.67
6.	1966-67	110.95		+110.95
7.	1967-68	1.95		+ 1.95
	Total costs	570.88	419.70	151.18

Source: Irrigation Department Headquarters, Rangoon.

As already stated, the construction works commenced in 1961-62 and finally finished in 1967-68. An examination of the scheduling of costs shown in Table 5.6 reveals a wide difference between the actual and the estimate; not to mention the difference in total construction years. It took altogether seven years for construction, although according to the agreed Protocol it was estimated only a five-year period.

By comparison from the above table, total costs were much more concentrated in the early years of the project in the estimate, while as it was a reverse situation in the actual construction periods. As may be expected from past experiences, the project was rushed to completion in the last two years, namely the fifth and sixth years. The additional cost incurred in the seventh year was for blanketing the seepage areas.

It is a rather difficult task for a complete or an accurate break-down of the share of labour, equipment and other materials in the total construction cost for the project as a whole. Nevertheless, a very

* The cost figures for the project are exclusive of interest charges on the foreign capital during the period of construction years.

rough break-down of cost figures could be attempted on the basis of cost estimates. The capital cost of the machinery necessary for the construction could be roughly about 20 per cent of the total cost. The main types of machinery involved are already shown in Table 5.3. As mentioned earlier, the entire capital cost of the machinery was not accounted to the project, since it was assumed that after the project was completed, it would still hold a salvage value. The operation of the machinery requires fuel, spare parts, labour for operating, servicing and repair. The cost for such items, however, entered the total cost. It was further assumed that the cost of depreciation for the entire machinery employed on the project taken as a whole was approximately 27 per cent of the capital cost of the machinery.

On the side of materials, there were several important components like cement, concrete and stones, particularly in the construction of the dam and the lining of the two main canals. Fortunately, stones were available in the vicinity; therefore reducing much of the cost of transporting them from other areas. A good part of the canals required lining to prevent loss of water and to ensure that the water reached the areas farthest away. The cost of lining accounted for about one-fifth of the total investment on the canals.

As far as labour is concerned, the major items of cost which involved the use of unskilled manpower were those on earthworks and stoneworks related with the dam, main canals and its distributaries. The main construction work was the erection of the earthen dam which involved both unskilled labour and machinery. Types of works included in this case were working borrow areas with excavators and scrapers, filling the body of the dam with watering and tamping using tractors, sheep foot rollers, bulldozers and water bowsers. Works like protection of the slopes of the dam with stones included trimming of slopes, laying of sand layers delivered from Kyaukpon river bed, hauling stones to the crest of the dam from the excavated spoil of the escape, and the pitching of slopes. The amount of earthwork and stones involved in the construction of the dam portion was 3,469,626 cu. yds. and 193,343 cu. yds. respectively.

The share of cost for unskilled manpower for the project as a whole was approximately 40 per cent of the entire cost. Obviously, unskilled labour had played a major role in the construction of the dam portion and the distribution systems. Most of the labour employed were from the project region itself, while some were recruited from neighbouring areas. Since most of them were underemployed or unemployed the construction of the project calls to a large extent on employment of resources which were relatively idle in the economy, involving by implication little or no social opportunity cost.

On the other hand, the cost component for skilled labour was roughly 10 per cent of the entire cost. Skilled labour includes engineers and technicians, both local and foreign. For the purpose of the analysis, semi-skilled machinery operators are also classified as skilled workers.

Once the project works are completed, it is the responsibility of the irrigation authorities to operate, maintain and repair the works over the expected useful life of 50 years. There were no estimates made for maintenance and operation costs. Actual maintenance costs for the project are divided into two main items, i.e. the ordinary repairs and the special repairs. By definition, ordinary repairs are those for minor damages, while as the special repairs include the repairing of major damages and substitution of major parts. Total maintenance costs involve the repairing of the canals, berm cutting, trimming and rodding, maintenance of headworks, structures, gates, masonry linings, transport, inspection roads and drainage works.

If more irrigation water is used to expand the irrigated tract, maintenance costs of canals would rise because of damages done by flowing waters. As it is done in most irrigated systems, lining of canals is applied to reduce seepage losses. Lining of a seven mile long Left main canal and a twelve mile long Right main canal would obviously increase maintenance costs; but greater benefits could also exist as a result of more water for irrigation. Furthermore, less water logging would reduce damages which in turn would reduce maintenance costs of canals. Table 5.7 presents the annual costs of operation including maintenance and repairs of the works.

The farmers in the region are not required to make any annual payments for the use of irrigation water. Therefore, the operating cost as well as part of the capital costs are mainly borne by the

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* Irrigation rates are not normally charged in the country. In fact, it is more or less concerned with politics rather than economic facts. It is believed that irrigation charges are included in other costs of farm inputs. Furthermore, it is believed that irrigation charges would have no significant effect on farmers' incentive to make profitable use of the water and also there is no doubt about the capacity to pay for these charges.

government. As far as private costs are concerned, there are individual costs of production at the farm level. These costs are clearly related to the increase in agricultural production made possible through irrigation. The costs of cultivation will rise as more farm equipment, more material inputs and more intensive labour are required for the irrigated fields. Table 5.8 presents the unit production cost per acre for selected major crops grown with irrigation water.

TABLE 5.7

Annual Operation and Maintenance Costs

Year	Maintenance Costs		Total Costs
	Ordinary Repairs	Special Repairs	(Kyats)
1970-71	269,100	150,718	419,818
1971-72	249,017	150,466	399,483
1972-73	263,539	95,825	359,364
1973-74	132,422	6,490	138,912
1974-75	267,894	40,003	307,892
1975-76	291,616	23,919	315,535
1976-76	323,677	40,237	363,914
1977-78	257,440	66,169	423,609
1978-79	175,221	278,698	453,919
1979-80	301,810	23,455	325,265

Source: Irrigation Department, Kyet-mauk-taung Irrigation Project, Kyaukpadaung.

TABLE 5.8

Unit Production Cost Per Acre (Kyats)

Crops	Unit Production Cost Per Acre (Kyats)		
	Commodities & Services	Labour Cost	Total
1. Long staple cotton	205	100	305
2. Short staple cotton	7	30	37
3. Sesamum	65	120	185
4. Groundnut	155	60	215
5. Pulses	50	50	100

Source: Irrigation Department Headquarters, Rangoon.

The unit production cost includes expenditures for commodities, services and labour. It excludes any charges made for irrigation water, land rent or interest on farm credit.

Farm equipment and material inputs are mainly supplied through government channels. More precisely, they are supplied through state-co-operatives, where prices are reasonably low. The supply of credit to the farmers is handled in the same way as the provision of farm equipment and others.

CHAPTER 6

AGRICULTURAL BENEFITS AND THE IRRIGATIONAL ASPECTS OF THE PROJECT

As in the consideration of project costs, an account of the benefits of the project must begin with the 'official' approach to benefit estimation. It will then be assessed in the light of actual experience to be followed later by an 'alternative' approach to estimation of benefits with necessary modifications. The 'official' approach to estimation of benefits was on the assumption that Kyet-mauk-taung project area, weather and the cropping pattern are similar to that of the Thitson project, which is about 30 miles away. On that basis, the cropping pattern after the completion of the project was planned.

For the project area, land utilization was initially estimated to be 100 per cent for the monsoon months and only 75 per cent for the winter months. The irrigated tract was estimated to be 30,000 acres where double cropping of monsoon and winter crops was originally planned. For the estimated irrigated tract, the average annual discharge run-off was predicted to be 97,000 acre feet. The annual depth of watering required according to the adopted cropping pattern of the Thitson project was 2.14 feet. If this is the case, then the total annual water requirements for 30,000 acres would simply be 64,200 acre feet (30,000 x 2.14 feet = 64,200 acre feet). Thus it was estimated that there would be ample water. Assuming that the planned cropping pattern adopted at Thitson project was formally followed, the planned annual agricultural benefits would be as detailed in Table 6.1.

The cropping pattern consisting mainly of long staple cotton, sesamum, groundnut and pulses, was planned for the estimated irrigated tract of 30,000 acres. The pattern included double cropping only for long staple cotton, which was regarded as the major crop to be grown with irrigation water. Groundnut and sesamum, which were traditional crops and mostly suited with the prevailing weather conditions, were included among the monsoon crops. Pulses were only planned as winter crops. As it is clear from Table 6.1, long staple cotton plays a major role in the estimated cropping pattern covering a total double cropping area of 16,800 acres.

The irrigation authorities had also made a future plan to implement improved water management after the establishment of the project.

TABLE 6.1

Expected Cropping Pattern and Costs and Returns of the Project*

Period	Crop	Area (Acres)	Cost Per Acre	Total Crop Value Per Acre	Net Value Per Acre (Kyats)	Total Benefits (Kyats)
(a) Summer	1. Paddy	900	75	100	25	22,500
(b) Monsoon Crops	2. Long staple cotton	9,300	150	400	250	2,325,000
	3. Groundnut	3,750	80	250	170	637,500
	4. Sessamum	11,550	60	100	40	462,000
	5. Chillies	2,700	120	730	610	1,647,000
	6. Orchards	1,800	100	150	50	90,000
	(Monsoon) Total	30,000				
(c) Winter Crops	1. Pulses	7,500	60	135	75	562,500
	2. Long staple cotton	7,500	150	400	250	1,875,000
	3. Onions	1,750	300	2,100	1,800	2,150,000
	4. Fallows or Pastures	2,500				
	5. Orchards	1,750	100	150	50	87,500
	(Winter) Total	22,000				10,859,000
	Grand Total	52,000				

Source: Irrigation Department, Kyet-mauk-taung Project.

* Cost, net value per acre and the total benefits were computed by the Irrigation Department.

Acreage of crops that were actually planned to be sown in the long run were as follows:

Crops	Initial Estimated Area (Acres)	% of Area	Long Run Planned Area (Acres)	% of Area
1. Long staple cotton	16,800	41.5	15,587	32.30
2. Paddy	900	2.2	6,419	13.30
3. Groundnut	3,750	9.2	7,025	15.00
4. Sesamum	11,550	28.6	7,697	16.00
5. Pulses	7,500	8.5	11,255	23.4
Total	40,500	100	48,283	100

For the long-run plan, pulses were seen as second in importance compared with long staple cotton. This could be viewed as a shift in the initial estimated cropping pattern towards pulses paddy and groundnut rather than sesamum, although cotton remained as the most important crop in the project area. It was predicted that a slow change will therefore take place; its direction being indicated by changes in general economic situations and government policies.

The general objectives of the cropping pattern were established by the authorities within the framework of agricultural and irrigation policy. Initially, the introduction of irrigation into the project region was for a deliberate change in the agricultural structure. The main intention was to shift from growing of toddy palm trees to irrigated agriculture. Crops under the agricultural plan would therefore have to serve two purposes, i.e. crops would have to be economically suitable not only for farmers in the region but also to fulfil the specific objectives of the government.

6.1 Alternative approach to benefit estimation. The project was finally completed in 1967-68. The annual water inflow which had been estimated to cover all irrigation requirements did not eventuate. During the fifteen years after its completion, the predicted full tank level was never reached. This unsatisfactory annual water inflow was partly due to low rainfalls in the upper catchment basins of the two rivers. There was also suspicion that annual rainfalls were a bit overestimated. In spite of conditions of water storage well below the planned design, there was always sufficient irrigation water for farmers when agricultural seasons arrive.

Annual water inflow and irrigation release are shown in Table 6.2. During a ten-year period from 1968 to 1977, average annual water inflow accounted for 33,000 acre-feet which is significantly different from the original estimate of 97,000 acre-feet. During the year 1979, the rainfall was below normal throughout the whole country, especially in the arid zone of the project area. The effects of dry weather were more pronounced in the project region in contrast with neighbouring regions. The water storage conditions in 1979 were as follows:

1.	The tank's water capacity at R.L. 53 feet on 16.11.79	10,405 acre-feet
2.	Dead storage at water gauge 37 feet	2,100 acre-feet
3.	Water for irrigation use	7,305 acre-feet
4.	Water losses through evaporation	900 acre-feet
5.	Irrigation use for 3,000 acres of late monsoon long staple cotton (1 acre-feet per acre)	3,000 acre-feet
6.	Water losses through evaporation (from February to April)	900 acre-feet
	Residual water storage	2,505 acre-feet

The above is a simple illustration of the average residual water storage left after irrigation uses. Generally speaking, pre-project study of water resources or rainfall was considerably inadequate. It should have aimed to measure the quantities of water actually usable as well as the frequency and scale of water shortages liable to influence the expected agricultural production. Nevertheless, the water storage was almost sufficient throughout the agricultural years, and hence there exists no problems of rationing of the allocation of irrigation water.

Project benefits could be described as (a) direct agricultural benefits, and (b) indirect and secondary benefits.

In principle, benefits of the project to the national economy cannot be concerned only with the direct benefits. Although indirect benefits are intangible and are difficult to measure economically, however, will have to enter the calculations of profitability of the project. The direct benefits include not only the present but also the future benefits. Principally, only the actual increase in agricultural output on land affected directly by the project is regarded as benefits.

The main objective for the construction of the project is to promote agricultural production in the area. With regard to the

TABLE 6.2

Water Inflow and Irrigation Release

Year	Water Inflow (Acre-feet)	Irrigation Release (Acre-feet)	Gauge Level (Acre-feet)	Water Depth (Feet)
1965	17,984	-	890.7	53
1966	7,798	7,158	887.4	49
1967	13,446	8,878	897.9	68
1968	25,406	7,657	906.3	68
1969	43,111	19,349	919.7	82
1970	37,072	26,795	922.6	85
1971	34,163	29,391	921.4	83
1972	11,725	11,607	900.5	63
1973	36,680	33,618	917.2	89
1974	28,725	20,946	918.0	80
1975	38,439	19,954	925.7	83
1976	44,523	24,971	933.1	95
1977	30,402	28,370	929.3	91
1978	-	-	-	-
1979	-	-	-	-

Source: Irrigation Department, Kyet-mauk-taung.

benefits it is preferable to look at the irrigable area, the cultivated area and the crops sown. After the project was completed, there was significant evidence for the increase of agricultural production in the irrigable area and the double cropping areas. The total irrigable and the cultivable area on both the canal systems are shown as below:

	Total	Left Canal	Right Canal
Irrigable area	29,896	7,010	21,776
Cultivable area	48,283	15,225	33,057

Out of the total cultivable area a cropping pattern which includes 15,887 acres of long staple cotton, 6,419 acres of paddy, 7,025 acres of groundnut, 7,697 acres of sesamum and 11,255 acres of pulses is planned by the authorities. Since there are no water charges involved in the irrigation system, there is a binding social constraint for farmers where they are obliged to grow only those planned crops with the use of irrigation water. In other words, farmers in the project are not allowed to grow any crops in free market conditions.

Although the planned cultivable area on the two canal systems is 48,283 acres, including the double cropping areas, its target was never reached throughout the cultivated years from 1968-69 to 1979-80. The table below represents the yearly actual cultivated areas. It shows the relationship of the area effectively irrigated to the irrigable and cultivable areas shown above, and its growth during the years of cultivation periods.

TABLE 6.3

Total Sown Acreage Matured Acreage and the Value of Crop Production

Year	Sown Acreage	Matured Acreage	Matured as % of Sown	Value of Crop* Production (000 Ks.)
1968-69	46,273	41,710	90.14	4745.89
1969-70	50,455	41,991	83.22	3,226.55
1970-71	50,603	47,772	94.40	5,444.55
1971-72	44,254	38,423	86.82	4,106.10
1972-73	44,573	29,931	67.15	2,842.73
1973-74	42,936	35,600	82.91	4,117.52
1974-75	39,052	23,208	59.42	7,955.37
1975-76	43,374	86,814	84.87	10,818.06
1976-77	41,288	27,746	67.20	7,091.73
1977-78	42,176	32,998	78.23	Not available
1978-79	47,481	31,986	67.36	-
1979-80	45,816	23,458	51.20	-
1980-81	38,979	24,066	61.74	-

Source: Irrigation Department Headquarters, Rangoon.

* The total value of crop production was computed by the Irrigation Department

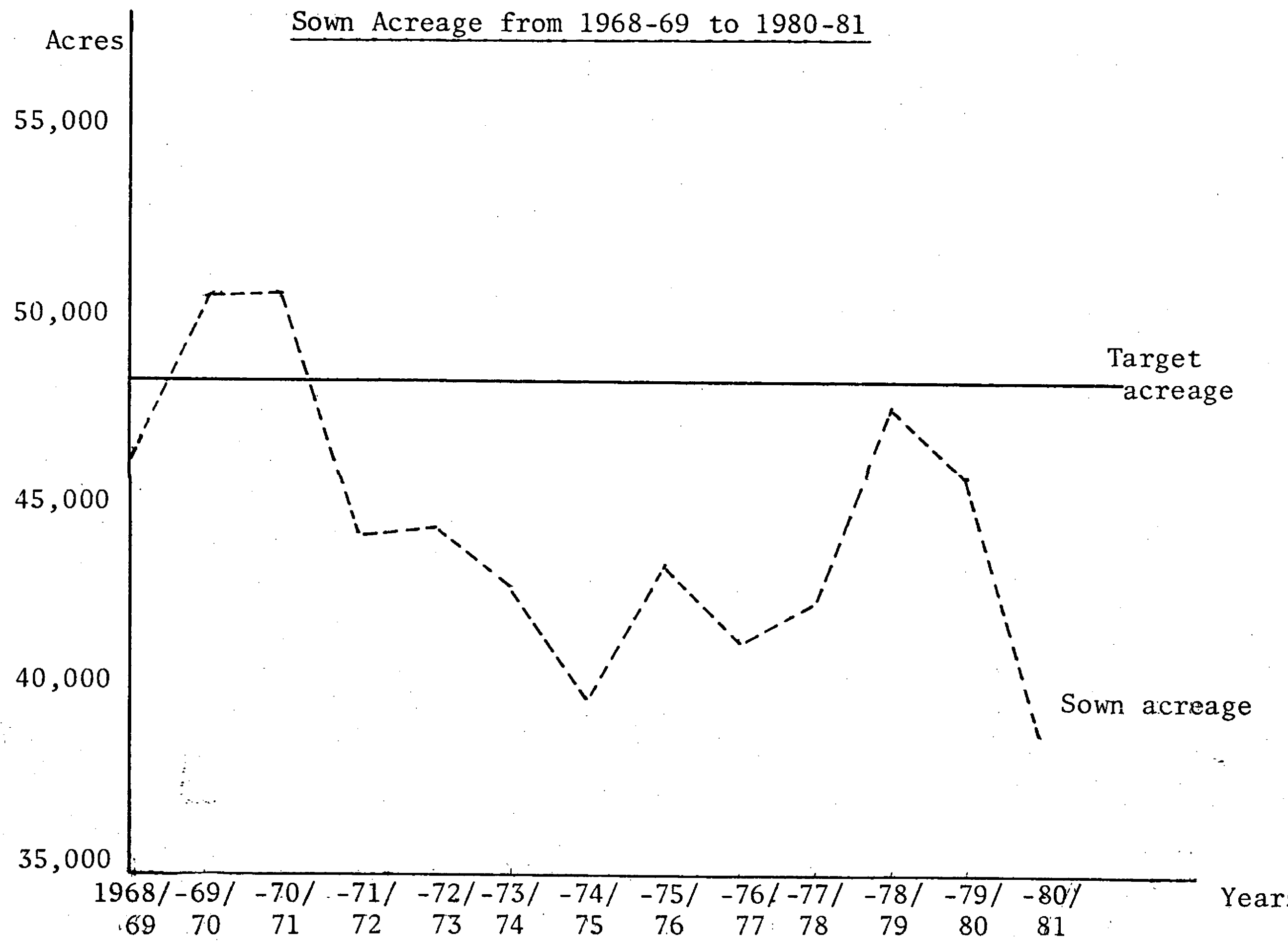
As may be seen from Table 6.3, only two years proved to have reached the targeted cultivable area. In principle, the irrigable area depends directly on the irrigation potential, but experience shows that the effectively irrigated area is usually below the actual irrigable area.

The area effectively irrigated does depend not only on irrigation potential but more importantly in the will, initiative and economic interest of the farmers.

The land use during the years from 1968-69 to 1980-81 turned out to be less intensively cultivated than the target. A graph is drawn for total sown acreage from the initial agricultural year to the present period.

FIGURE 6.1

Sown Acreage from 1968-69 to 1980-81



There are yearly fluctuations with significant increases and decreases (Figure 6.1). Here, sown acreage is shown with double cropping figures including acreages of monsoon and winter crops.

As far as the comparison with benefit estimation with other years is concerned, the agricultural production, matured acreage together with farm costs of the agricultural year of 1976-77 could be taken as an example. The statistics for the agricultural year of 1976-77 which is a normal year can be seen in Table 6.4.

The total acreage was only 27,748 acres, while the total sown acreage accounted for 41,288 acres (Table 6.4) and hence a significant difference exists between the sown and the matured acreage. The destruction of the sown acreage was due to unseasonal rainfalls during the months of May and June where the crops were still standing in the fields.

For the same agricultural year of 1976-77, a comparison of areas between 'estimated acres' and 'actual acres' can be made as below:

TABLE 6.5

Comparison of Acres Between 'Estimate' and 'Actual'

Crops	Acres		
First Crop	Estimate	Actual	
		Sown Acreage	Matured Acreage
1. Paddy	900	4,117	2,791
2. Long staple cotton	9,300	4,026	2,010
3. Groundnut	3,750	5,010	4,510
4. Sesamum	11,550	16,482	10,940
5. Chillies	2,700	-	-
6. Orchards	1,800		
Second Crop			
7. Pulses	7,500	2,320	1,956
8. Long staple cotton	7,500	3,561	661
9. Onions	1,750	-	-
10. Fallows, pastures, manure	3,500	756	749
11. Orchards	1,750	-	-
12. Others			
Total areeas	52,000	41,288	27,746

TABLE 6.4

Matured Area, Cost and Value of Crop Production (1976-77)

Crops	Matured Acreage	Value of Crop Production ('000 Ks.)	Cost of Commodities Per Acre (Ks.)	Cost of Labour Per Acre (Ks.)	Crop Value Per Acre (Ks.)	Net Benefits Per Acre (Ks.)	Total Benefits (Ks.)
1. Sesamum	10,940	1470.34	65	120	134.4	- 56.6	- 553,564
2. Paddy	2,791	1237.53	80	120	443.4		
3. Groundnut (Pyant)	747	313.29	155	60	419.4	207.4	152,686.8
4. Groundnut (Htaung)	307	210.68	210	60	686.2	416.2	127,773.4
5. Long staple cotton	5,907	2274.28	205	100	804.09	499.09	
6. Groundnut (Kyank-kon)	3,456	1010.88	155	60	292.5	77.5	267,840
7. Others	3,598						
Total	27,746	7091.73					1,603.53

In Table 6.5 'Others' includes corn seeds and leaves, tomatoes and chillies. As it is obvious from the table, there is a significant difference between acres of 'estimate' and 'actual'. Generally speaking, the sown or the matured acreage throughout the agricultural years were far below the estimate.

In all cases, some of the greatest shortfalls were on the irrigation affected lands where on-farm investments in drainage or levelling would have played an important role. It must be concluded that either the returns to such investments were not financially attractive to farmers, or there have been institutional deficiences that prevented their taking place. Unfortunately, there is no information on this.

To the extent that promotion of cash crops like cotton was seen as a benefit to the project, such benefits would have been overstated since the land substitution that took place was in favour of domestically consumed crops such as groundnuts, oilseeds and especially tobacco.*

Year to year changes in the cropping pattern are mainly the result of government agricultural policy towards cotton growing. The factors behind these changes are quite complex but it is believed that they are a reflection of the increased efficiency of irrigation water management and on-farm application methods. In part, the maintenance of canal structures and the small amount of canal lining would have contributed to a higher cropping intensity too. Yearly fluctuations in the cropping pattern are not the result of variations in water supplies determined by weather variability only. The farmers' attitude towards irrigation and the willingness to co-operate in the agricultural plans has also played a part.[1]

Table 6.7 shows the growing of cotton 'before' and 'after' the project. The period 'before' the project represents the years during construction; the period 'after' represents the agricultural years from 1968-69 to 1976-77.

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* The yearly variations in the total value of crop production are already shown in Table 6.3. Cost of commodities and services and labour cost for various crops will be shown in the Appendices. It will be seen that the cost of production for cotton is rapidly growing throughout the years.

[1] Tables showing the details of sown acreage, matured acreage, value of crop production, and farm costs of various crops from 1968-69 to 1976-77 will be presented in Appendices.

TABLE 6.7

Cotton Before the Project

Year	Cultivated Area (Acres)	Yield (Viss/Acre)	Price (Kyat)
1966	2,658	77.10	1.55
1967	2,341	47.85	1.55
	After the Project		
1968-69	13,122	95.85	3.50
1969-70	11,012	55.00	3.50
1970-71	10,990	53.80	3.50
1971-72	9,675	20.36	3.50
1972-73	12,306	43.05	3.50
1973-74	12,152	65.28	3.50
1974-75	12,293	81.90	3.50
1975-76	12,126	90.32	7.00
1976-77	11,786	114.80	7.00

Source: Irrigation Department, Kyet-mauk-taung.

The cultivated area of cotton had risen to a plateau of over 12,000 acres during the years from 1972-73 to 1975-76. In response to local agricultural policies and priorities, its cultivated area had changed throughout the years. Also, it is important to note that yield per acre may have risen in response to price adjustments by the government. At present, the cotton plan is in full swing, strongly backed by local government policies and agricultural price increases. Even in the light of these, there exists several difficulties and bottlenecks. Besides cotton, there are also other plans for various crops. But as cotton is badly needed as a raw material input, it has been given a top agricultural priority.

Furthermore, a comparison of 'before' and 'after' the project for other major crops such as groundnut and paddy can also be made (Table 6.8).

No major changes in the cultivated areas of groundnut occurred before and after the project (Table 6.8). On the other hand, yield per acre had dropped sharply from the highest (40 baskets) to the lowest (6.5 baskets). Surprisingly, price for groundnuts has risen significantly from 6.0 Kyats to 45.00 Kyets. This was due to the adjustment of agricultural prices by the government in 1973-74.

TABLE 6.8

Groundnut Area, Yield and Price
Before and After the Project

Year	Cultivated Area (Acres)	Yield (Basket/Acre)	Price (Kyet/Basket)
	Groundnuts - Before Irrigation		
1965	4,288	9.13	6.00
1966	4,320	15.00	6.00
1967	4,210	25.23	6.00
	After the Project		
1968-69	6,229	40.00	6.00
1969-70	6,910	36.00	6.00
1970-71	8,084	40.00	7.00
1971-72	6,816	20.00	6.00
1972-73	5,535	18.00	7.00
1973-74	3,860	21.00	55.00
1974-75	4,547	20.00	45.00
1975-76	5,840	8.00	45.00
1976-77	5,010	6.50	45.00

Source: Irrigation Department, Kyet-mauk-taung.

Similarly, a comparison can also be made for paddy, which is also one of the major crops in the project region (Table 6.9).

It is important to note that paddy had been given more attention in the later agricultural years. Yield per acre and the official price of paddy has risen throughout the years, though not very significantly. Increased areas in paddy are reflected by changes in the overall agricultural situations.

The acreages of cotton, groundnut and paddy with other crops grown in the project area added to the total sown acreage already shown in Table 6.3. As against little or no agriculture before the project, it does make substantial positive contributions to agricultural development in the region.

TABLE 6.9

Paddy Area, Yield and Price Before and After the Project

Year	Cultivated Area (Acres)	Yield (Basket/Acre)	Price (Kyat/Basket)
	Paddy - Before the Project		
1965	2,366	13.27	3.0
1966	1,227	12.85	3.0
1967	881	13.41	3.0
	After the Project		
1968-69	631	22.70	3.0
1969-70	3,298	22.78	5.0
1970-71	4,214	34.06	6.0
1971-72	5,254	34.18	6.0
1972-73	4,235	20.23	6.0
1973-74	4,997	25.44	10.0
1974/75	4,581	22.50	10.0
1975-76	5,694	31.79	10.0
1976-77	4,117	44.34	10.0

6.2 Irrigational Aspects of the Project. The performance of an irrigation project depends on the compatibility of water, land and people and the availability of supplementary agricultural inputs. The supply and demand of irrigation water is, of course, a key element. Hydrological studies are required to ascertain the quantity and reliability of the supply of water and its seasonal variations. Studies of disruption losses are also needed to arrive at reliable estimates of water available at the farm level.

The demand for water is derived from the water requirements of the agricultural output that the land and the farmers in the command area are expected to produce. The determinants of water requirements are climate, the nature of soil in the project area, the prospective market for various agricultural products, crops in the selected cropping pattern, and the ability and willingness of the farmers to make use of the water.

To make the best economic use of the available water, a cropping pattern has to be determined with the largest net value of output, which is physically possible in the command area. Net value of output per acre and irrigation requirements are the essential features of a feasible cropping pattern. Together they determine which cropping pattern is most profitable within the limits set by available land and water.

The cropping pattern for the Kyet-mauk-taung area was planned long before the project was finished. As mentioned before, a cropping pattern was adopted from a region similar to the project area. If an optimum cropping pattern is to be determined for the local farmer, yields should be based on what the farmer is likely to achieve in the immediate future. A key element for the optimum cropping pattern is the irrigation requirements of different crops sown in this area. Water requirements depend on the evapotranspiration of the soil and plant, and will also vary from place to place for particular crops according to climatic conditions.

Water requirements for cotton, the main crop in the project area, are small in the initial stages of plant growth, reach a maximum roughly equal to potential evapotranspiration during the end of the rapid growth and the flowering stage of the plant and decline thereafter. Differences in total water requirements of various crops determine differences in time and length of the growing season. In actual practice, difference in water requirements appear to be much larger than many have assumed. It is obviously of considerable importance for the problem of optimum utilization of water to know whether or not there are substantial differences in water requirements of various crops. If an extreme case is accepted that water requirements for all crops are assumed to be the same, the most profitable cropping pattern is simply the one with the highest net value per acre, which will then also have the highest value per acre foot of water.

Effective rainfall in the upper catchments of the two rivers and the water storage in the reservoir determine the water available at the farm level. Only a small part of rainfall is effective in the area owing to runoff and deep percolation. Water in the fields is also lost through percolation and evaporation, where available water for irrigation is partially affected. The efficiency of irrigation has been assumed to be 70 per cent in the project area. The distribution of irrigation requirements over the year varies, of course, inversely with the distribution of rainfall. Since it is a very dry region, a large part of the water requirements is met by irrigation even in the rainy season. In the dry season, water requirements have to be met mainly from irrigation, and moreover they tend to rise in the hot season.

In principle, there are fixed water requirements for particular crops. Cotton, for example, is assumed to require 2.9 feet of water per acre to reach maturity. Table 6.10 shows water requirements for various crops in the command area.

TABLE 6.10

Water Requirements for Various Crops in the Command Area

	Crops	Water Requirements (feet per acre)
1.	Pre-monsoon long staple cotton	2.9
2.	Pre-monsoon paddy	5.7
3.	Pre-monsoon groundnut	2.0
4.	Pre-monsoon sesamum	2.0
5.	Monsoon paddy	4.8
6.	Late monsoon long staple cotton	2.9

Source: Irrigation Department, Kyet-mauk-taung.

Pre-monsoon and late monsoon long staple cotton have the same water requirements per acre. Since cotton is grown all over the project area, its water requirement is a major determinant in the total water requirement. It can be seen that water requirement of crops sown on the Left and the Right Canal systems are different (Table 6.11).

Water requirements for paddy is the highest as it consumes a lot in the early stages of growth. Since most of the lands on the Right Canal are covered with sandy soils, there is a need for more water per acre than with the Left system which has heavier soils. It is important to see that these irrigation requirements are met or there would probably be a crop failure. The amount of water in excess of the necessary requirements has no impact on output and is simply wasted. If less water is provided than specified, one would expect some reduction

TABLE 6.11

Water Requirements for Crops on the Two Main Canals (1979-80)

Crops	Acres (Left Canal)	Acres (Right Canal)	Total Acre Feet (Left Canal)	Total Acre Feet (Right Canal)	Water Requirement Acre Feet Per Acre Left Canal	Water Requirement Acre Feet Per Acre Right Canal
1. Pre-monsoon long staple cotton	3924	108	11112	935	2.8	5.0
2. Pre-monsoon paddy	791	686	4156	4000	5.2	6.3
3. Monsoon paddy	4673	969	18176	8796	3.9	9.0
4. Late monsoon long staple cotton	418	3387	1170.4	16935	2.8	5.0

Source: Irrigation Department, Kyet-mauk-taung.

in yield but not complete crop failure; and necessary or greater supply of water might be expected to increase yields to some extent. There is much evidence that indicates that the losses attributable to insufficient watering are less than proportional to the shortages of the water supply. Supplying less water than the required quantity to the fields disturbs the moisture tension in the soil making it harder for plants to extract water and dissolved nutrients from the soil surrounding their roots. However, most plants are well adapted to mild variations in soil moisture content so that small deficiencies in water supply do not have much effect on plant growth. But, as the deficiencies become more and more severe, the effects on growth can become more marked. Trials in the demonstration farms show that small deficiencies in water supply produces no changes in yield. Table 6.12 represents the utilization of irrigation water up to December, 1979.

The organization of state farms or collective farms are established by the government in the command area. Fifty acres of state farms are located on the Left Canal and another 50 acres on the Right Canal. There

TABLE 6.12

Utilization of Irrigation Water, December 1979

Crops	Planned Acreage	Sown Acreage	Water Utilization (Acre-Feet)
1. Pre-monsoon long staple cotton	4,152	4,032	11,647
2. Pre-monsoon paddy	1,000	1,427	8,156
3. Groundnut & sesamum	1,770	1,246	2,469
4. Late monsoon long staple cotton	4,468	3,805	3,140
5. Monsoon paddy	5,000	5,642	26,972

Source: Irrigation Department, Kyet-mauk-taung.

are also 85 acres of co-operative farms organized and encouraged by the government. There is a possible extension of these types of farms if they prove to be successful. The water requirements for the 50 acres of state farms on the Left Canal system are shown as below:

TABLE 6.13

Water Requirements of State Farms on the Left Canal

Crops	Acreage	Water Requirement (Feet Per Acre)	Total Water Utilization (Acre Feet)
1. Paddy	20	7	140
2. Cotton	20	3.5	70
3. Sunflower	10	2.0	20
	50		230 Acre Feet

The establishment of these state farms is mainly not only for increased production in the command area, but also to serve as an example to be followed by other irrigation areas. Paddy and cotton are normal crops sown in the area, while sunflower is supposed to be an experimental crop which bears no real significance. The following tables show how the basis of the water requirements for paddy, cotton and sunflower are calculated.

TABLE 6.14

Water Requirements for Paddy

	Needed Amount of Water
1. Fruit watering (for levelling and growth of seeds)	1.5 feet
2. Second watering (for early growth)	2.0 feet
3. Third and fourth watering (for plant growth)	2.0 feet
4. Fifth watering (for plant growth)	1.5 feet
Therefore, total needed amount of water	7.0 feet

TABLE 6.15

Water Requirements for Cotton

	Needed Amount of Water
1. First watering (for levelling and land preparation)	1.0 feet
2. Second watering (for planting)	1.0 feet
3. Third watering (for plant)	1.0 feet
4. Fourth watering (for plant growth to maturity)	0.5 feet
Total needed amount of water	3.5 feet

Sunflower, unlike the other two crops, has a relatively low water requirement.

TABLE 6.16

Water Requirements for Sunflower

	Needed Amount of Water
1. First watering (for land preparation and plantation)	1.0 feet
2. Second watering (for plant growth)	0.5 feet
3. Third watering (for growth to maturity)	0.5 feet
Total needed amount of water	2.0 feet

The 50 acres of state farms on the Right Canal involve 30 acres of groundnuts and 20 acres of sesamum. Water requirements for groundnuts and sesamum are presented below.

TABLE 6.17

Water Requirements for Groundnuts and Sesamum on the Right Canal

Crops	Acreage	Water Requirements	Total Utilization of Water
1. Groundnuts	30	2 feet	60 acre feet
2. Sesamum	20	2 feet	40 acre feet
Total	50		100 acre feet

The total water requirements for the 100 acres of state farms on both the main canals are only a small fraction of the total water requirements needed for the whole region. The Agriculture Department is in charge of the management of these state farms which have proved to be successful to a certain extent. On the other hand, a small amount of co-operative farms, 85 acres in size, is in active operation in the command area, where they are jointly managed by the government and the participant farmers. There is a certain amount of pressure currently going on for the expansion of such farms. These farms differ from those of state farms, where they are operated mainly for the purpose of cotton growing. The total water requirement for cotton in the co-operative farms are presented as below:

Crop	Acreage	Water Requirements (Feet Per Acre)	Total Utilization of water
Cotton	85	3.5 feet	297.5 acre feet

The traditional method of irrigation in the project area is by gravity water flow. Water from upstream storage reservoir is carried through a canal system to field distributaries across the areas to be irrigated. The fields in the irrigated area stretch with boundaries mixed, but more or less in an even level and each with its own position between the canal and the drainage channels. The distance between the canal and the drainage may be a few hundred yards.

Irrigation is accomplished by letting water flow from the main canal into the field channels and then into the fields. This type of irrigation is for rice areas where the fields are evenly levelled. But in areas where fields stretch in terraced steps one after the other, a field to field irrigation system is practised. The method is to let water flow from the canals into the first terrace of fields. Once these fields are flooded, the bunds are opened allowing the water to move to the next terrace where the process is repeated until the flooded water moves across the entire distance between the canal and the drainage channel. Sometimes, it takes a few days to several weeks for this procedure of watering.

There are, on the other hand, several disadvantages of field to field irrigation. Among them is the loss of evaporation and percolation while the water moves along the terraces and into the drainage. In some cases, the continuous flow of water across fields may carry with it the soil nutrients and chemical fertilizers put on the fields. The best possible way to avoid some of these losses is to construct a network of spreading canals where water could be conveyed separately to each plot. Separate drainage channels may also be preferred to prevent any field to be water-logged.

One of the most distinguishing factors in the irrigation aspects of the project is the water control or water management. Without precise water control, the possibilities for double or multiple cropping are greatly reduced. Furthermore, there can also be a loss in the main crop production, for example, such as cotton without a proper water control system. Some of the new high yielding varieties produced by the demonstration farms or those brought in from other sources need precise water control and require large inputs of fertilizers and protective chemicals.

Water for irrigation can be both a traditional as well as a modern input for increased production. The discrimination between the two categories depends on the conveyance and the utilization of water. Water as a traditional input is merely no more than watering of the fields, but it serves as a modern input when irrigation water supply can double traditional yield and increase total output.

In the crucial process of moving to scientific agriculture, the farmers in the project region will have to be involved in certain decision making. Decisions made by the farmers will affect the adoption of new variety seeds, the application of fertilizers and protective chemicals, and more importantly the adoption of new agronomic practices suitable for irrigation techniques. In addition, changes in the cropping pattern and purchase and use of modern farm implements will also be affected. On the other hand, decisions to construct their own field channels must be arrived at by some consensus of farmers in the area or enforced by the government.

Modern water control is needed in the conduct of farm operations over the irrigated area. At present, there is a common agreement reached by the farmers and the irrigation authorities on the use of a particular variety of cotton or other major crops like groundnuts, so that irrigation water can be provided on the date of planting over the whole area at the same time when it is needed to support crop growth.

The farmers are at the moment already enjoying a certain amount of agricultural benefits. The region has also experienced a relatively high level of sophistication in agriculture. This is mainly due to improved water management which allows for more careful irrigation for the main crops and open opportunities for double cropping. The improved water control and the more sophisticated agricultural situation had also resulted in a higher demand for modern farm implements.

For the purpose of water management, the government has already organized an efficient administrative body. Among villages that lie in the irrigated area, the government is currently encouraging the establishment of farmers' irrigation associations. Some of the villages have recently organized such associations which are already in active operation.

The foregoing gave an account of the irrigational aspects of the project and the water use efficiency at the farm level. In real practice, cropping patterns diverge somewhat from the original plans, affecting water requirements in the region as a whole. Furthermore, economic considerations and actual water availability also condition the use of water at the farm level. All these have to be taken into account in the calculation of the agricultural benefits.

CHAPTER 7

SOCIAL BENEFIT-COST ANALYSIS OF THE PROJECT

A Financial Profitability Analysis with Market Prices

7.1 Discounted Cash Flow Approach

The project was expected to create many types of benefits. One of them was to save foreign exchange that otherwise would have been spent on cotton imports. Cotton produced in the project area is supposed to provide some portion of cotton raw inputs that is necessary for a huge textile mill in the neighbouring region. Other benefits include the promotion of the standard of living and income of farmers who shifted from the cultivation of toddy palm-trees to more stable income and profitable crops grown with irrigation water.

The project involves two separate branches of cost, i.e. cost incurred by the Irrigation Department under the Ministry of Agriculture and Forestry and the loan agreement between the Soviet Union and Burma. The Irrigation Department incurred nearly 60 per cent of all expenditures in connection with the construction, operation and design of the project. For the project, the foreign loan or the foreign exchange component of the construction cost was made available as part of a general agreement under which the Soviet Government undertook to help construct the dam. All foreign equipment used by the project was purchased from the Soviet Union.

The Soviet loan was to be amortized over a period of twelve years following completion of the project works, with a rate of interest of 2.5 per cent on the due balance. The principal repayments commenced in 1968 and finally in 1979 the total loan was completely repaid. It cost the government about 28.2 million Kyats in local currency, which includes the interest charges.

During the construction years, the capital outlays of the project works were mainly financed by the Ministry. It also incurred the costs of farm equipment, agricultural credit and extension services made available to the farmers. Ever since the project was completed in 1967 the government introduced extension services mainly for the adoption of new seeds and the technical use of irrigation water.

The foreign loan was tied specifically to this particular project in the sense that it could not be used elsewhere in the economy. The cost of using such a loan is outflows abroad in the form of annual principal repayments and interest charges. If the loan is untied, then the cost of its use will be the value at shadow prices of the equipment purchased with the loan. However, in a country like Burma where heavy import controls are exercised and where capital goods rather than consumer goods are major imports, and further, because of the existence of a black market, there is still a need to compute a foreign exchange premium on the foreign exchange component in the social benefit-cost analysis.

While the government incurred most of the costs of the project, the farmers who now settled in the irrigated area are the chief direct beneficiaries. From Table 7.1 below, a cash flow account of the farmers as a group can be calculated. Farmer payments include only cost of services and labour as listed in the table. Unlike most irrigation projects, there are no rates on irrigation or other charges in the project region. These charges are probably believed to be included in the sales of farm equipment or other inputs such as fertilizers.

TABLE 7.1

Value of Crop Production, Cost and Net Value

('000 Kyats)

Year	Value of Crop Production	Cost of Inputs	Cost of Labour*	Net Income
1968-69	4745.89	599.4	1182.3	2964.19
1969-70	3326.55	690.2	1437.1	1199.25
1970-71	5444.55	976.2	1830.9	2637.45
1971-72	4106.10	925.2	1665.1	1515.80
1972-73	6286.90	962.4	1771.0	3553.50
1973-74	10477.70	784.5	3247.1	6446.10
1974-75	10454.50	3809.2	3182.2	3463.10
1975-76	10818.00	4238.6	4084.6	2494.80
1976-77	12091.70	8966.1	1522.1	1603.50

Source: Irrigation Department, Kyet-mauk-taung.

* Cost of labour was estimated by Irrigation Department and is based on prevailing wage rate in the region for these years.

The value of crop production showed sharp variations throughout the years from 1968-69 to 1976-77 (Table 7.1). The prices of output are administered prices and it is assumed that these have not been changed. Also on the cost side, both the cost of inputs and the cost of labour had risen significantly which leaves a narrow difference of net benefits to the farmers in the project area.

Using the data from Table 7.1 a cash flow account may be computed for the farmers as a group. The formulae for it is as follows:

$$\text{Net Farm Income} = \text{Gross Returns} - \sum_{i}^{n} P_i \; X_i$$

where P_i are prices of all inputs used and X_i are quantities of ith input used

Here the value of crop production may represent the gross returns. Cost of inputs include depreciation of farm equipment, machinery, cost of fertilizers, etc. Cost of labour involves hired farm labour plus value of family farm labour. For farmers as a group, the present value of net farm income or net benefits attributable to irrigation is 32,094.8 thousand Kyats.* With this approach it is obvious that the direct benefits accruing to the project farmers are more than its associated farm costs.

In the case of the Kyet-mauk-taung project, benefits and costs are evaluated and compared on two situations, namely (1) the development of the economy of the region with the creation of the project, and (2) any development that would occur without the project. This 'with and without' principle measures the difference in contribution to the project when it is evaluated in terms of market values.

The Kyet-mauk-taung project, like any other surface irrigation project, provides adequate water at the time and place where required to enable local farmers to adopt intensive agriculture. Any additional agricultural output due to the project is normally regarded as the benefits from irrigation water. Furthermore, the net value added due to the project depends upon the difference between (a) cropping pattern and yields without irrigation, and (b) cropping pattern and yields with irrigation. It may be noted that the years of 1965, 1966 and 1967 during the construction periods where some portion of the storage water

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* A discount rate of 8 per cent is used to arrive at the present value of net benefits for farmers mainly because it is the ruling official bank rate in the country. Furthermore, it is assumed that it reflects the social preference of the nation as a whole. This is the current official rate and in Burmese context can be treated as social time preference rate.

was released for cropping is regarded as the agricultural situation before or without irrigation*. The years starting from 1968-69 after the final completion of the project is, of course, the agricultural years with irrigation.

Comparisons based upon the 'with and without' principle are computed for major crops like cotton, groundnut, sesamum and paddy. Table 7.2 shows the with and without situation of cotton.

It is obvious that cotton with irrigation contributes more direct irrigation benefits than the without situation. In this comparison, production cost refers to farm cost of commodities and services.

Table 7.3 shows the with and without situation of groundnut. It is clearly obvious that with and without situation of groundnut does not make much difference. Table 7.4 shows the with and without situation of paddy.

Thus, it is obviously seen from the above tables that the comparisons based upon with and without situation showed that the major crops have a higher economic advantage with irrigation than without irrigation. The yield rates under 'with irrigation' have increased significantly throughout the years. The extent of this increase in crop yields depends on various economic, administrative and social factors. Table 7.5 shows the difference in the gross value of agricultural produce for the three major crops.

It may be noted that the gross value of agricultural produce only for the three major crops 'with irrigation' is 1.8 times the corresponding figure of 'without irrigation'. Cost of cultivation in the form of seeds, farm labour, fertilizers and other expenses considerably increased after the introduction of irrigation. Thus, the net value of produce increased only 1.2 times the situation without irrigation. The difference between the net value of produce is shown in Table 7.6. This increase in the net value of produce is considered as the net additional benefit of the irrigation project. It is recognized that the agricultural situation in the project region may not improve without the benefit of irrigation even with the increasing use of improved high-yielding varities of seeds and new technologies of dry farming. Therefore, the net benefits from the project is shown by the differences of the benefits with irrigation and the benefits without irrigation.

TABLE 7.2

Cotton

Without Irrigation

Year	Cultivated Area (acres)	Yield (Viss/acre)	Price (Ks/Viss)
1965	-	-	-
1966	2658	77.10	1.55
1967	2341	47.85	1.55
Average	2499.5	62.47	1.55

Cotton With Irrigation

Year	Cultivated Area (Monsoon Acres)	Yield (Viss/Acre)	Cultivated Area (Winter Acres)	Yield (Viss/Acre)	Price (Ks/Viss)
1968-69	2860	95.85	-	-	3.5
1969-70	2336	55.00	184	60.1	3.5
1970-71	5579	53.80	-	-	3.5
1971-72	7053	20.36	69	80.85	3.5
1972-73	6121	43.05	2548	69.29	3.5
1973-74	3662	65.28	3034	142.19	3.5
1974-75	3865	81.90	3703	73.86	3.5
1975-76	3804	90.32	3560	91.50	7.0
1976-77	4026	114.80	3561	100.26	7.0
*Average	3898.3	95.67	3608	88.54	5.6

Item	With Irrigation	Without Irrigation
1. Cultivated area (acres)	7506.3	2499.5
2. Yield (Viss/acre)	95.67**	62.47
3. Price (Ks/Viss)	5.6	5.6
4. Gross value of crop production ('000 Ks.)	4064.60	874.4
5. Production cost ('000 Ks.)	1538.79	301.56
6. Net value ('000 Ks.)	2525.81	572.84
7. Farm labour cost ('000 Ks.)	750.6	142.47
8. Direct irrigation benefits	1775.21	430.37

Source: Irrigation Department, Kyet-mauk-taung.

*Note. The last three years with irrigation is taken as comparison with the three years without irrigation. Also for comparison, a constant price is used.

** Average of monsoon crop yield rate is taken as yield rate for irrigated cotton because winter yield rates in the first five years of the project were unstable and in later years are approaching monsoon yield rates.

TABLE 7.3

Groundnut Without Irrigation

Year	Cultivated Area (Acres)	Yield (Basket/Acre)	Price (Kyat/Basket)
1965	4288	9.31	6.0
1966	4320	15.00	6.0
1976	4210	25.23	6.0
Average	4272.66	16.45	6.0

With Irrigation

Year	Cultivated Area (Monsoon)	Yield (Basket/ Acre)	Cultivated Area (Winter)	Yield (Basket/ Acre	Price (Kyat/ Basket
1968-69	5494	40.00	-	-	6.00
1969-70	5692	36.00	1211	25.23	6.00
1970-71	2075	40.00	6000	40.00	7.00
1971/72	6812	20.00	-	-	6.00
1972-73	5479	18.00	-	-	7.00
1973-74	3809	21.00	-	-	55.00
1974-75	3975	20.70	-	-	45.00
1975-76	4386	8.00	66	9.99	45.00
1976-77	3612	6.50	-	-	45.00
Last 3-year average	3991.0	11.73	-	-	45.00

Item	With Irrigation	Without Irrigation
1. Cultivated area (acres	3991.0	4272.66
2. Yield (basket/acre)	11.73	16.45
3. Price (Ks/basket)	45.00	45.00
4. Gross value of crop production ('000 Kyats)	2106.64	3162.83
5. Production costs ('000 Ks.)	618.60	519.13
6. Net value ('000 Ks.)	1488.04	2643.70
7. Farm labour cost	239.46	247.80
8. Direct irrigation benefits	1248.58	2395.90

Source: Irrigation Department, Kyet-mauk-taung.

TABLE 7.4

Paddy Without Irrigation

Year	Cultivated Area (Acres)	Yield (Basket/Acre)	Price (Ks/Basket)
1965	2366	13.27	2.0
1966	1227	12.85	3.0
1967	881	13.41	3.0
Average	1491.3	13.7	3.0

With Irrigation

Year	Cultivated Area (Monsoon)	Yield (Basket/ Acre)	Cultivated Area (Winter)	Yield (Basket/ Acre)	Price (Ks/Basket)
1968-69	631	22.7	-	-	3.0
1969-70	3298	22.78	-	-	5.0
1970-71	4214	3406	-	-	6.0
1971-72	5254	34.08	-	-	6.0
1972-73	4235	20.33	-	-	6.0
1973-74	4997	25.44	-	-	10.0
1974-75	4581	22.50	-	-	10.0
1975-76	5694	31.79	-	-	10.0
1976-77	4117	44.34	-	-	10.0
Last 3-year average	4797.3	32.87			10.0

Item	With Irrigation	Without Irrigation
1. Cultivated area (acres)	4797.3	1491.3
2. Yield (Basket/acre)	32.87	13.17
3. Price (Ks/basket)	10.00	10.00
4. Gross value of production ('000 Ks.)	1576.87	196.40
5. Production cost ('000 Ks.)	383.79	33.55
6. Net value ('000 Ks.)	1193.08	162.85
7. Farm labour cost ('000 Ks.)	575.67	101.70
8. Direct irrigation benefits	617.41	61.15

Source: Irrigation Department, Kyet-mauk-taung.

TABLE 7.5

Gross Value of Agricultural Produce With and Without Irrigation ('000 Ks.)

Value of Agricultural Produce	Without Irrigation	With Irrigation
1. Cotton	874.40	4064.60
2. Groundnut	3162.83	2106.64
3. Paddy	196.40	1576.87
Total gross value of agricultural produce	4233.63	7748.11

TABLE 7.6

Net Value of Produce With and Without Irrigation ('000 Ks.)

Net Value of Produce ('000 Ks.)	With Irrigation	Without Irrigation
1. Cotton	1775.21	430.37
2. Groundnut	1248.58	2395.90
3. Paddy	617.41	61.15
Total net value of produce	3641.20	2887.42

7.2 Discounting of Benefits and Costs

When benefits and costs are to be discounted in the calculation of benefit cost ratio on the internal rate of return, it becomes important to determine the length of the entire economic life of the project. It could not be considered unlimited even if the physical components of the the project is well maintained. In estimating the whole technical life, the silting of the reservoir, major and minor replacements and other requirements will have to be taken into account. It is further assumed that its economic life would be shorter than its technical life. Since the present value of benefits or costs which may be realized in the distant future are expected to be very low even at any reasonable rate of discount, it is considered unnecessary to carry out any calculations beyond a period of 40 years after the completion of the project. Therefore, the entire economic life of the project is estimated to be 40 years.

In order to aggregate all benefits and costs over the entire life of the project, it is necessary to convert future benefits and costs to their present values through the use of a reasonable rate of discount. It will have to represent the time preference of present consumption over future consumption which is reflected by the society. If benefits and costs are considered from the national point of view, the relevant rate of discount may be called the social rate of discount.

As Burma had experienced three official bank rates which are 3 per cent, 6 per cent and 8 per cent throughout the years from the early sixties to the late seventies, it is assumed that these bank rates represent the social time preference, which may further be regarded as the social rates of discount. The Burmese economy is largely a managed economy. Therefore, in the computation of the net present values of the project, benefits and costs may be discounted with three different social rates of discount.

Table 7.7 shows benefits and costs by year at market prices. Labour used during the periods of construction is divided into skilled and unskilled labour, where the former represents engineering and other technical staff employed in the project. Similarly, farm labour can also be categorized into family unskilled labour and hired labour.

In Table 7.8, direct net benefits are discounted by 4 per cent and 5 per cent rate of discount, which produces the zero net present value. The computed internal rate of return is 4.11 per cent, which is higher than the previous official bank rate (3 per cent) or the interest rate charged on the Soviet loan, but lower than the present bank rate (8 per cent). As statistical data for both benefits and costs are only available up to the year 1976-77, expected future costs and benefits for the entire project life of 40 years are computed on the basis of average of these years.

Table 7.7b represents the discounted values of benefits and costs using social rates of discount of 3 per cent, 6 per cent and 8 per cent.

According to the UNIDO method, the net present worth of the project will be expressed in terms of net aggregate consumption. Annual principal repayment of the Soviet loan, together with its interest charges and payments like irrigation fees, may be regarded as transfer flows.

TABLE 7.7a

Project Benefits and Costs at Market Prices

	1961-62	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77
Benefits																
1. Value of Crop Production								4745.8	8326.5	5444.5	4106.1	6286.9	10477.7	10454.5	10818.0	7091
2. Construction Costs	1189	2529	4348	8592	29061	11095	195									
(a) Unskilled labour	535	645	374	5038	17957	10741	195									
(b) Skilled labour	354	354	354	354	354	354	-									
(c) Domestic materials	-	-	-	-	-	-	-									
(d) Foreign exchange	300	1530	3620	3200	10750	-	-									
3. Operation & Maintenance Costs										419,8	399,4	359,3	138.9	307,8	315.5	363.9
(a) Unskilled labour										335,8	319.5	287,4	111,1	246.2	252.4	291.1
(b) Other costs										84,0	79,9	71,9	27.8	61,6	63.1	72.8
4. Farmer Agricultural Costs								1781,6	2127,3	2807,0	2590,2	2679,4	4031,4	6991,2	8323.1	5488.1
(a) Cost of commodities & services								599.4	690,2	976,2	925,2	962,4	784,5	800.2	4238.6	3966.1
(b) Cost of farm labour								1142.3	1437.1	1830,9	1665,1	1771,0	3247,1	3182,2	4084.6	1522.1
(b.1) Family unskilled labour								472.9	574.8	782.3	666,0	708.4	1298,8	1272.8	1633.8	608.8
(b.2) Hired unskilled labour								709,4	862.3	1096.6	999,1	1062.6	1948.3	1909.4	2450,8	913.3

TABLE 7.7b

Discounted Benefits and Costs at Market Prices*

	Social Rate of Discount		
	3%	6%	8%
1. Benefits ('000 Ks.)			
Value of crop production	141067.1	64560.9	42982.5
2. Construction cost ('000 Ks.)	49409.1	43139.8	39822.0
(a) unskilled labour	30416.8	26306.5	24104.1
(b) skilled labour	1907.8	1565.8	1635.6
(c) domestic materials			
(d) foreign exchange	17084.4	15167.5	14082.3
3. Operation and maintenance cost ('000 Ks.)	4777.3	2380.9	1758.8
(a) unskilled labour	3821.8	1904.7	1407.0
(b) other repairs	955.5	476.2	351.8
4. Farmer agricultural costs ('000 Ks.)	65908.9	32812.1	21961.8
(a) cost of commodities and services	23873.0	14244.6	9403.0
(b) cost of farm labour	42035.9	18567.5	12558.8
(b.1) family unskilled labour	16814.3	7427.0	5023.5
(b.2) hired unskilled labour	25221.6	11140.5	7535.3

* Value of crop production and farmers crop production. Costs are aggregated from Tables 7.2-7.6.

TABLE 7.8

Internal Rate of Return (IRR)*

	Gross Costs	Gross Benefits	4 Per Cent	Net Benefits	Discounted Value (4%)	6 Per Cent	Discounted Value (5%)
1.	1189	-	0.961	- 1189	- 1141.4	0.952	- 1129.5
2.	2529	-	0.924	- 2529	- 2326.6	0.907	- 2276.1
3.	4348	-	0.888	- 4348	- 3826.2	0.863	- 3739.2
4.	8592	-	0.854	- 8592	- 7303.2	0.822	- 7045.4
5.	29061	-	0.821	- 29061	- 23830.0	0.783	- 22667.5
6.	11095	-	0.790	- 11095	- 8765.0	0.746	- 8210.3
7.	195	-	0.759	- 195	- 146.25	0.710	- 138.4
8.	1781.6	4745.8	0.730	2964.2	+ 2163.9	0.676	+ 2003.8
9.	2127.2	3326.5	0.702	1199.3	839.5	0.644	772.3
10.	3226.8	5444.5	0.675	2217.7	1496.9	0.613	1359.5
11.	2989.6	4106.1	0.649	1116.5	724.6	0.584	652.0
12.	3038.7	6286.9	0.624	3248.2	2026.9	0.556	1805.9
13.	4170.3	10477.7	0.600	6307.4	3784.4	0.530	3342.9
14.	7299.0	10454.5	0.577	3155.5	1820.7	0.505	1593.5
15.	8638.6	10818.0	0.555	2179.4	1209.6	0.481	1046.1
16.	5852.0	7091.7	0.533	1239.7	657.0	0.458	567.8
17.	4000.0	8000.0	0.513	4000.0	2052.0	0.436	1744.0
18.	-	-	0.493		1972.0	0.415	1660.0
19.	-	-	0.474		1896.0	0.395	1580.0
20.	-	-	0.456		1824.0	0.376	1504.0
21.			0.438		1752.0	0.358	1432.0
22.			0.421		1684.0	0.341	1364.0
23.			0.405		1620.0	0.325	1300.0
24.			0.390		1560.0	0.310	1240.0
25.			0.375		1500.0	0.295	1180.0
26.			0.360		1440.0	0.281	1124.0
27.			0.346		1384.0	0.267	1068.0
28.			0.333		1332.0	0.255	1020.0
29.			0.320		1280.0	0.242	968.0
30.			0.308		1232.0	0.231	924.0
31-34					4928.0		3596.0
35.			0.253		1012.0	0.181	724.0
36-39			0.253		4048.0		2896.0
40.			0.208		832.0	0.142	568.0
					+ 732.9		- 6070.6

* No gestation period is allowed in computing this table. This amounts to preparing an ex-ante project appraisal if information on costs and benefits were available. Thus we have discounted costs and benefits from year 1.

However, in the present consideration, irrigation fees are zero payments, since there are no charges made by the project. As for other transfer flows, these may not enter into the aggregate consumption computations simply because these represent transfer flows from one group to another and therefore have no effect on the aggregate consumption.

The market value of net aggregate consumption benefits of the project can be computed according to the formulae shown below.

MC = (1) Value of agricultural production

Less - (2) Construction costs

(3) Operation and maintenance costs

(4) Farmer agricultural costs.

MC represents the net aggregate consumption benefits at market prices. For three different social rates of discount, the net aggregate consumption at market prices can be seen as below.

	Social Rate of Discount	Net Aggregate Consumption (MC)
1.	3%	20971.8
2.	6%	- 13771.9
3.	8%	- 20560.0

Therefore, it is obvious that the net aggregate consumption shows positive value only for the social rate of discount of 3 per cent while for the rest it is negative. Similarly, different benefit-cost ratios can also be computed.

	Social Rate of Discount	Benefit-Cost Ratios
1.	3%	1.17
2.	6%	0.82
3.	8%	0.67

It is now obvious that only for a low rate of discount, the project seems to have a positive net present value and a benefit-cost ratio greater than one. For the other rates of discount, the project cannot be regarded as financially sound. Note that we have used the market prices (which are largely administered prices in Burma) for valuation of costs and benefits and no indirect effects are taken into account.

7.3 Estimation of the National Parameters

Shadow Price of Foreign Exchange. Burma, like many other developing countries, has been facing a balance of payments problem for the last twenty years. In such a situation the official exchange rate may not represent the true value of foreign exchange earned or spent. For the valuation of the real value of foreign exchange, it becomes necessary to make adjustments by using an appropriate premium on the official exchange rate.

For the past two decades, the government was struggling to maintain the dollar value of the Kyat, the local currency. In other words, the government was exercising import controls where major imports were mostly capital goods rather than consumer goods. During the late 1960s and 1970s the government was strongly pushing ahead with a strategy of industrialization through development of heavy industry and import substitution. As consumer goods were considered less essential than capital goods, there was a tendency of less imports of these goods. As a result, there appeared an illegal black market where most consumer goods were smuggled into the country from the Thai border.

Obviously, it was clear that an American dollar or other foreign currency in exchange is worth substantially more than 7 Kyats which is the current official exchange rate. Therefore, in the social analysis of the project, the opportunity cost of foreign exchange relative to its official exchange rate can be expressed as $(1 + \emptyset)$, where $\emptyset$ represents the foreign exchange premium.

There is still another important consideration which has to be kept in mind in the social analysis. It was believed or assumed that during those days when the Soviets agreed to sell their machinery and other equipment needed for the project, the prices for these were subsidized by a certain percentage. However, taking into consideration all possible effects for the need of a shadow price of foreign exchange, it is clear that there is a need for a positive premium to be attached to the foreign exchange cost component of the project.

According to the UNIDO, there is a simple formulae for calculating an average shadow exchange rate which is as follows:

$$SER = OER \frac{(M + Ti) + (X + Si)}{M + X}$$

$$SER = OER \frac{(M + Ti) + (X + Si)}{M + X}$$

where, SER = shadow exchange rate

OER = official exchange rate

M = c.i.f. of value of imports

X = f.o.b. value of exports

Ti = import tax revenues

Sx = export subsidies

The above shows the standard conventional formulae. However, instead of the above formulae, a standard conversion factor is used by the World Bank for the valuation of non-traded goods to be compatible with the traded ones. The standard conversion factor may be defined as follows:

$$SCF = \frac{X + M}{X + Si + M + Ti}$$

where, SCF = standard conversion factor. The other variables are the same as the above formulae. Using this formulae, and substituting all necessary values, the standard conversion factor worked out to be 0.80.*

According to the basic formulae, the relationship between the shadow exchange rate (SER) and the standard conversion factor (SCF) is defined as below:

$$SER = OER \frac{1}{SCF}$$

where the ratio of (SER) and (OER) can also be shown as:

$$\frac{SER}{OER} = \frac{1}{SCF} = \frac{1}{0.80} = 1.25$$

This implies that there is a need of a premium of 25 per cent to be attached to the foreign exchange component of the project.

Social Rate of Discount. As noted earlier, benefits and costs will have to be discounted with an appropriate rate of discount, which would reflect the true social preferences of the country. There are, of course, ideal formulas for working out the social rate of discount which

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* A similar study was conducted by Sinka and Bhatia in "Economic Appraisal of Irrigation Projects in India". A value of SCF = 0.86 has been used by the World Bank in the evaluation of irrigation projects in India. It is assumed that a similar SCF could also be used in the evaluation of irrigation projects in Burma. This is the best estimate available for use in our project in Burma in the absence of Burmese data to enable us to estimate our own. For procedures used see Bhatia and Sinha (1982).

may include the growth rate of per capita consumption, the elasticity of diminishing marginal utility of consumption and finally the pure time preference. Since these economic indicators are not available for the Burmese economy and data are not available to compute it, the official bank rates ranging from the early 1960s to the present period are taken into account as the social rates of discount. As Burma is largely a command economy and these official bank rates being introduced on national economic circumstances, these rates are believed to represent the collective preferences of the country as a whole. In the present study, the official bank rates of 3 per cent, 6 per cent and 8 per cent will be regarded as the social rates of discount.

Shadow Price of Investment. In Burma, like many developing countries, the level of savings investment cannot be assumed as optimal. Therefore, it is considered that the market value and the social value of investment cannot be the same, and hence there is a need to calculate the shadow price of investment. It may be defined as the present value of additional consumption generated by a unit of investment. A formulae for this is shown as below:

$$P^{INV} = \frac{(1 - s)q}{i - sq}$$

where, P^{INV} = shadow price of investment

S = marginal rate of reinvestment of profits in the economy

q = marginal rate of return on investment

i = social rate of discount.

It may be noted that the shadow price of investment is defined as a function of opportunity cost of capital, rate of reinvestment and the social rate of discount.

As for the economy as a whole, the marginal rate of return on investment and the marginal rate of reinvestment of state profits is assumed to be 10 per cent.* Using this and the social rates of discount of the shadow price of investment can be computed as below:

(a) for 3 per cent social rate of discount:

$$P^{INV} = \frac{(1 - s)q}{i - sq}$$

$$= \frac{(1 - 0.10)(0.10)}{(0.03) - (0.10)(0.10)}$$

$$= 4.5$$

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* Since Burmese economy is largely a managed economy the current rate used in Burma is 10 per cent. This rate is considered reasonable for our purpose.

(b) for 6 per cent social rate of discount:

$$P^{INV} = \frac{(1 - S)q}{i - sq}$$

$$= \frac{(1 - 0.10)(0.10)}{(0.06) - (0.10)(0.10)}$$

$$= 1.8$$

(c) for 8 per cent social rate of discount:

$$P^{INV} = \frac{(1 - S)q}{i - sq}$$

$$= \frac{(1 - 0.10)(0.10)}{(0.08) - (0.10)(0.10)}$$

$$= 1.28$$

The shadow price of investment may vary over time due to the present and future rates of marginal productivity of investment and savings. As it is obvious from the above computations, the shadow price of investment may also vary indirectly with the social rate of discount. In the present case-study, the national parameters, S and q, are considered as constants, leaving the only variation with the social rate of discount. It is clear that with a higher social rate of discount, the shadow price of investment tends to be low. Unlike the shadow price of foreign exchange or any other accounting prices, it is related to the economy as a whole, and not to the characteristics of the project in concern.

Shadow Price of Labour. The Kyet-mauk-taung project had increased employment of labour especially unskilled labour during its period of construction as well as after its completion. One of the ways in which employment of unskilled labour can be seen from the social point of view is to compute the shadow price of labour or the shadow wage rate.

It is clear that in Burma and in other developing countries there are distortions in the labour market, in a sense that there is unemployment or underemployment of labour. Hence, the market wage rate may not equal the social opportunity cost of labour. In the calculation of this shadow wage rate, some of the important factors needed to be considered are (a) the agricultural or any output foregone in the economy or the region on account of employing labour on the project, and (b) the additional cost of consumption when labour is employed or in other words the additional cost in terms of increased aggregate consumption.

In the present study, the output foregone in the region was so little that it has to be ignored and hence may be regarded as zero. It is further believed that farmers in the area would be totally unemployed in the absence of the dam. Therefore, the opportunity cost of labour is assumed to be negative, which implies that it is below the level of market wage rate. The formulae for the shadow wage rate is defined as below:

$$SWR = M + S\ (P^{INV} - 1)\ W$$

where, SWR = shadow wage rate

M = the marginal product in past employment or output foregone

S = rate of savings from profit

P^{INV} = shadow price of investment

W = market wage rate or construction wage rate

For the unskilled labour or for the farmers in the project region, the rate of saving from profit is assumed to be no more than 10 per cent, which implies that nearly 90 per cent of their agricultural income or wages is spent on consumption. In extreme cases, it could also be assumed that unskilled workers spent all their wages on consumption so that their savings is zero. Since those unemployed or underemployed farmers had turned out to be unskilled labour for the project, it may be safely assumed that they may have the same rate of savings like the farmers. Hence, using the rate of savings as 10 per cent, the shadow price of investment as 1.8 and the construction wage rate to be 6 Kyats, the shadow wage rate is worked out as follows:

$$\begin{aligned} SWR &= M + S\ (P^{INV} - 1)\ W \\ &= 0 + 0.10\ (1.8 - 1)\ 6 \\ &= 0.48 \end{aligned}$$

The above implies that the shadow wage rate is to be regarded as 48 per cent or 50 per cent of the market wage rate.

The government had also employed agricultural extension staffs in the project area after its completion, where their contribution of service to the area may be assumed as nearly twice their labour wage. As noted earlier, there are about 50 acres of state farms and another 50 acres of co-operative farms, where these extension people are employed. They may be regarded as skilled labour and the role in which they played is of vital importance to the area. However, their labour wages are considered as transfer flows and will not be included in the net aggregate consumption. On the other hand, skilled labour during and after the project is assumed that the value of services contributed is worth according to the actual market wage. Hence, it is regarded as unnecessary to attach any premium to skilled labour.

In the evaluation of the present project, various national parameters are needed and for the sake of simplicity, many of these are assumed to remain constant throughout the entire life of the project. In this context, the marginal propensities to save for farmers as well as unskilled labour are assumed to remain constant at 10 per cent. While on the other hand, the marginal rate of return on investment and the marginal rate of reinvestment of state profits are also assumed to remain constant as 10 per cent. In addition to this, the marginal propensity of the government to save is assumed to be 1.0, which implies that the government is in a strong position to invest. According to the above assumptions, a table for the national parameters may be shown as below.

TABLE 7.10

National Parameters

1.	Shadow price of unskilled labour	$\lambda_1 = 0.50$
2.	Foreign exchange premium	$\emptyset = 0.25$
3.	Marginal rate of return on investment	$q = 0.10$
4.	Marginal rate of reinvestment of state profits	$S = 0.10$
5.	Social rates of discount	i = 3%, 6%, 8%
6.	Shadow price of investment	P^{INV} = 4.5, 1.8, 1.28
7.	Marginal propensity to save for farmers	$S^F = 0.10$
8.	Marginal propensity to save for unskilled labour	$S^L = 0.10$
9.	Marginal propensity to save for the government	$S^G = 1.0$

7.4 Valuation of Crop Production

In addition to the national parameters above, the social benefit-cost analysis of the Kyet-mauk-taung project would also require a number of shadow prices for some major crops like cotton, paddy and pulses. All these commodities are not traded goods; in a sense that these are not exported nor imported. There are, in fact, tradable commodities which are being consumed domestically in the region. However, if these are regarded as tradable commodities their respective shadow prices could be calculated on the basis of (a) the c.i.f. or the f.o.b. prices, (b) the shadow price of foreign exchange, and (c) the costs of transport, processing, storage or handling in the domestic market.

Burma at present is a net exporter of rice and on the other hand a net importer of cotton. Hence, the f.o.b. or the c.i.f. prices of rice and cotton may be considered as their respective economic prices. These prices are based on available export and import prices published in the 'Agricultural Statistics, 1979-80'. Since these prices had changes in the last decade or so, it would be fairly difficult to forecast any possible price changes in the future. On the other hand, it may also be important to take into consideration the price changes of particular agricultural inputs. However, on account of empirical difficulties, it may be assumed that changes in the prices of major outputs will be offset by changes in inputs and hence will leave the results of social benefit-cost analysis un-influenced.

Although economic prices for traded commodities like rice and cotton are based upon their border prices, economic prices for non-traded commodities like groundnut and sesamum can be derived by applying a food-grain conversion factor (FCF) to their financial prices. The FCF can be estimated using the quantity exported or imported, the financial prices and the economic prices. Its formulae can be seen as follows:

$$\text{FCF} = \frac{(\text{Q rice x PE rice}) + (\text{Q cotton x PE cotton})}{(\text{Q rice x PF rice}) + (\text{Q cotton x PF cotton})}$$

where, Q = quantity exported or imported

PE = economic prices

PF = financial prices

Using the data of exports, imports, financial prices and economic prices of the mentioned crops, the FCF may be worked out as below.*

$$\text{FCF} = \frac{(369 \times 1392.7) + (164 \times 7591.4)}{(369 \times 530) + (164 \times 4355)}$$

$$= 1.9$$

Therefore in the social valuation of total output of the project as a whole, it may be revalued with a FCF value of 1.9. Formerly, the valuation of total crop production attributable to irrigation water is done with market prices or administered prices fixed by the government.

* In the year 1978-79, Burma exported 369 thousand tons of rice at an economic price of Ks. 1392.7 per ton and its respective financial price is Ks. 580 per ton. In the same year, the country imported 164 thousand tons of raw cotton with economic prices of Ks. 7591.4 per ton. The financial price for cotton in that year was Ks. 4355 per ton.

However, it is assumed that these administered prices fail to reflect the true consumers' willingness to pay. This is mainly because of the existence of the illegal black market for agricultural products. Therefore, there is a need for an adjustment of these prices. Hence, a shadow price multiplier higher than that of market prices may be used in the social valuation of total crop production.

It may be mentioned that the valuation of output at export or import prices must be adjusted by the shadow price of foreign exchange and domestic transport costs. The shadow price of foreign exchange is already computed as 1.25 and if we further assume that for both crops the domestic transport costs are Ks. 300 per ton, the adjusted shadow prices may be shown as below:

Commodities	Market Prices (Ks./ton)	Shadow Prices (Ks./ton)	Shadow Price Multiplier
1. Rice	1392.7	2040.8	1.46
2. Cotton	7591.0	9788.75	1.29

Therefore from the above calculations an average shadow price multiplier of 1.40 may be used in the social value of total crop produce.

7.5 Social Benefit-Cost Analysis of the Project

In the social benefit-cost analysis of the Kyet-mauk-taung project, there will be three commonly used decision criterions in the evaluation process. They are (a) net present value (NPV) or the net present worth, (b) benefit cost ratio or the B/C ratio, and (c) the internal rate of return (IRR). In the financial analysis, the conventional method is of evaluating benefits and costs valued at their market prices. In the social benefit-cost analysis, these market prices may be substituted by appropriate shadow prices so that the project is evaluated in terms of adjusted market prices which may reflect the true socio-economic conditions of the country.

On the benefits side, the total value of crop production is to be adjusted by a shadow price multiplier of 1.40. On the other hand, i.e. on the costs side, the foreign exchange cost component may be adjusted upwards by a foreign exchange premium of 25 per cent while as the unskilled labour component of before and after the project may be adjusted downwards by 50 per cent of the market wage rate. The table below shows the value of crop production, construction cost operation and maintenance costs and farmer agricultural costs in terms of their shadow prices.

TABLE 7.11

Present Social Value of Benefits and Costs at Shadow Prices

Items	Social Rate of Discount		
1. Benefits	3%	6%	8%
Present value of crop production ('000 Kyats)	197493.94	90385.26	60175.5
Present Value of Costs			
2. Construction costs			
(a) Unskilled Labour	15208.4	13153.25	12052.05
(b) Skilled labour	1907.8	1665.8	1635.6
(c) Foreign exchange compound	21355.5	18959.3	17602.8
3. Operation and Maintenance			
(a) Unskilled labour	1910.9	952.35	703.5
(b) Other maintenance costs	955.5	476.2	351.8
4. Present Value of Farmer Agricultural Costs			
(a) Cost of commodities and services	23873.0	14244.6	9403.0
(b) Cost of farm lbour	21017.95	9283.75	6279.4
(b.1) Family unskilled labour	8407.15	3713.5	2511.75
(b.2) Hired unsilled labour	12610.8	5570.25	3767.65
Sub-total	44890.95	23528.35	15682.4
Present Value of Net Benefit	111264.89	31650.01	12147.35

From the above table, the net present value (NPV) and the benefit-cost ratios for the three different social rates of discount can be computed. It may be seen that for a higher social rate of discount, the net present value on the benefit-cost ratio tends to be lower. A comparison for both economic criterions can be seen in the tables below. It is important to note that there lies a significant difference with the social rates of discount of 6 per cent and 8 per cent which are, in fact, the current official bank rates.

TABLE 7.12

Net Present Value ('000 Ks.)

Items	Market Prices	Shadow Prices
1. Net present value (3% social rate of discount)	20971.8	111264.89
2. Net present value (6% Social rate of discount)	- 13771.9	31650.01
3. Net present value (8% social rate of discount)	- 20560.1	12147.35

TABLE 7.13

Benefit-Cost Ratio

Items	Market Prices	Shadow Prices
1. Benefit-cost ratio (3% social rate of discount)	1.42	3.89
2. Benefit-cost ratio (6% social rate of discount)	0.68	1.93
3. Benefit-cost ratio (8% social rate of discount)	0.48	1.38

From the above tables, it may be noted that for the social rates of discount of 6 per cent and 8 per cent the net present values at market prices which measures the absolute economic profitability of the project tend to show negative signs. It must be said that except for a very low social rate of discount of 3 per cent, the project when evaluated at market prices is uneconomically sound. On the other hand, when the project is evaluated at shadow prices, it shows all positive signs for the three social rates of discount. Therefore, the project is economically sound only from the social point of view. In terms of benefit-cost ratios, the project tends to have a benefit-cost ratio which is far less than one for the two higher rates of discount. But all benefit-cost ratios proved to be higher than one when computed in terms of shadow prices. The table below shows the comparison of the foreign exchange component, the unskilled labour component and the total value of crop production in terms of their respected market and shadow prices.

TABLE 7.14

Comparison of Foreign Exchange Cost Unskilled Labour and the Total Value of Crop Production

Items ('000 Ks.)	Social Rates of Discount		
	3%	6%	8%
1. Total value of crop production (market prices)	141067.1	64560.9	42982.5
2. Total value of crop production (shadow prices)	197493.4	90385.26	60175.5
3. Unskilled labour component (market prices)	76274.5	46778.7	38069.9
4. Unskilled labour component (shadow prices)	38137.25	23389.35	19034.95
5. Foreign exchange component (market prices)	17084.4	15167.5	14082.3
6. Foreign exchange component (shadow prices)	21355.5	18959.3	17602.8

7.6 Sensitivity Analysis

In a social benefit-cost analysis, a sensitivity analysis involves in finding out the effects of possible variations if some of the assumptions made on the net present value, the benefit cost ratio or the internal rate of return. If it is done properly, the sensitivity analysis can help evaluating the project in a more reasonable manner.

The national parameters of social rate of discount, the shadow price of investment and others are assumed to remain constant through the project life. Therefore, without any changes made in whatever is assumed to remain constant, possible differences can be seen if the parameters like the premium foreign exchange component of the project changes. Working out the sensitivity analysis only for the internal rate of return, the following table shows the differences in it when some of the parameters involved are changed.

TABLE 7.15

Internal Rate of Return (IRRI)

Items	IRR
1. Market prices	4.11 per cent
2. Shadow prices (benefits, unskilled labour, foreign exchange)	8.8 per cent
3. Shadow prices (unskilled labour, foreign exchange only)	8.5 per cent
4. Roubles (foreign exchange component) at current exchange rate (Ks. 10 = 1 rouble)	3.2 per cent
5. Shadow price of foreign exchange only. (25 per cent premium with all other costs and benefits at market prices)	2.5 per cent

As may be seen from the above table, the internal rate of return proves to be substantially higher when the shadow prices of benefits, unskilled labour and foreign exchange cost are involved. There is, in fact, a slight variant in the IRR when only shadow prices of unskilled labour and foreign exchange are taken into account. The IRR (3.2 per cent) tends to be significantly low when the foreign exchange component of the project is revalued at the current exchange rate of Ks. 10 to a rouble.* Usint only a premium of 25 per cent on the foreign exchange cost with all other costs and benefits at market prices, the IRR (2.5 per cent) seems to be slightly different. The IRR at market prices (4.11 per cent) is far below the present bank rate of 8 per cent, but the IRR at shadow prices (8.8 per cent) proved to be a little higher. Therefore, it must be concluded that the project is not financially sound when evaluated at market prices, but proved to be economically sound when evaluated at shadow prices. For social and economic reasons, it must be said that the project has made an important contribution to both the development of the national economy and to the welfare of the local people in the project region.

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* The former exchange rate during the construction periods was Ks. 5.29 = 1 rouble.

CHAPTER 8

REGIONAL DEVELOPMENT EFFECTS OF THE KYET-MAUK-TAUNG PROJECT

8.1 Indirect Benefits of the Project

The region prior to the project had nine villages in the upper catchments of the two river basins, which were later resettled inside the project area. Income earned from toddy farming was relatively low compared to incomes in neighbouring areas. Besides, high temperature climates and little water available for drinking purposes had resulted in a number of social and health problems. On the other hand, the area had eventually turned into almost a semi-desert. As a result of the project, the area was economically opened up. Agriculture was established inside the project area, thus leading to stable and high average incomes and a larger population.

In any development consequence, social spillovers or effects should also be considered if we are concerned with the general welfare of the local people. Once the region experienced such low rainfalls that there was little or no water even for domestic purposes, not to mention water for agricultural purposes. Much worse, it was accompanied by a widespread prevalence of water-related diseases. Nowadays, with adequate water supplies from the dam, most of these awful diseases have completely disappeared.

The project, like many other economic activities, is believed to have several backward and forward linkages. In this connection, it may be noted that the use of irrigation water stimulated increased use of major agricultural inputs. The Agricultural Corporation jointly with the Township Peoples' Council are actively involved in the supply of major inputs to the farmers. This resulted in a routine flow of necessary inputs at a needed time, where most of the project farmers enjoyed relatively low input prices. This is due to heavily subsidized price schemes by the government.

The farm credit system is already organized and well under way on the national level. Since farmers in the project region are entitled to receive these credits, the Agricultural Bank handles its distribution in advance of agricultural seasons. The credit is later reimbursed after the harvest is sold to the government.

Marketing, processing and transporting of farm products of the project are mostly handled by local consumer and producer co-operatives. The Agricultural Bank, which is the main body of finance for farmers, also plays the role of financier for all capital costs in this matter. As soon as the harvest season is over, farm produce is collected by these co-operatives, and later transported to markets or factories.* In the case of cotton, a huge transportation program is involved in transporting it to a nearby textile mill. Therefore, it must be said that the project had stimulated many economic activities.

8.2 Resettlement and Employment in Transitional Phase

The resettlement and rehabilitation program involved nine villages to be removed from the catchment areas. Resettlement costs accounting for Ks. 229972.50 was provided by the government. In the removal of the nine villages, seven of them were sited close to the dam, while the remaining two were located afar, though still in the irrigable area.

The government also provided housing and other necessary facilities for the resettled people. Land distribution schemes were made in the irrigable area, where the chief beneficiaries were those farm familes with no private land ownership. The government had also code-named the nine resettled villages as No.1 to No. 9. Under the new land settlement schemes, 46 households of the No. 8 village received an average of four acres of cultivable land per farm family. The No. 4 village, which inhabited 105 households received an average of two acres per farm family. Generally, for the whole project area, land distribution was about 5 acres per farm family. In 1965-66, the government also provided Ks. 23700 as a fund for development and livestock breeding.

Under the labour-hiring schemes for the construction works, there was employment for at least one member in every family. With employment opportunities and land distribution benefits, each farm family received nearly Ks. 70 per month during the periods of construction.** Besides these, there was also provision of many other facilities such as road links between villages, primary schools, village medical clinics and tube-wells for

* The local authorities have to make sure that the bulk of the harvest arrives safely into the legal channels, i.e. to ensure none of these is sold on the black market. However, in spite of all rigidities and stiff controls, a certain portion of farm produce appears in the illegal market.

** The official exchange rate in terms of US dollars, is already expressed in Chapter 5.

drinking water. The No. 9 village with 108 households and being located quite afar from others, was the first to be provided with a tube-well and for religious affairs, a Buddhist monastery was also installed.

Villagers from these resettled areas formed the majority of labour employed during the construction of the project. This settled not only many of the off-farm families' unemployment problems, but also the problems of hired manual labour by the project. Because of the need of a huge labour force of nearly 5,400 workers, some of them have to be migrated from other neighbouring areas, and later resettled in the irrigated areas. However, for those migrated labour there were little or no resettlement costs such as building labour camps or schools for the children or even health clinics.

In the base clearing of the dam and the total stripping of the steep loamy slopes of the two rivers which was mostly done by excavators, nearly 10 per cent was believed to be hand-trimmed by manual labour. Also, in the construction of the main body of the earthen dam, labour was involved in the borrow areas jointly with the heavy earthmoving machines. As the project involved many technicalities, most of the hired labour was based upon their professional skills. It may be noted that the disguised unemployment in agriculture in the local area was economically and potentially utilized in the project. It is believed that those trained in technical works were later transferred to other carry-on irrigation projects. After the completion of the project, what highly benefitted the area was the widespread art of carpentry and masonry.

8.3 Regional Development Effects

On the other hand, the construction of this project had resulted in several economic and commercial connections with other socialist countries, especially the Soviet Union. During the periods of the late 1960s, it emerged as one of the largest and most heavily invested irrigation projects in the country. Due to some high technical engineering methods, it took a few more years to construct than the initial planned period. The needed technology, mechanical equipment and experts which were imported from the Soviet Union also benefitted many of the local engineers.

Some questions regarding the distribution of irrigation water were never quite complex, since there is ample supply of water in the dam. This resulted in a large number of users whose decisions did not interact with one another and besides it solves the problem of achieving efficient utilization of water resources as an essential agricultural input.

The establishment of farmers' irrigation associations in many of the villages in the project region has helped improved not only the water problems, but also the co-operativeness of all irrigators involved. The Irrigation Department at the project site did everything in its authorative power to ensure that these are well organized and properly managed. In these associations the irrigators are, of course, bound to abide by the rules and regulations laid down by the irrigation authorities. Only on rare occasions, there appeared a conflict of interest between the two parties.

Although there is no data available at the farm level, there is substantial evidence that farmers in the project region have improved their standards of living. The market value of agricultural production clearly represents a direct benefit to the project region, since the earnings flow directly to the farmers. During the past recent years, the region had stepped up in cotton production. On account of this, the value of foreign exchange saved, however, does represent benefits to the government.

As far as the whole project region is concerned, the cost flows including farm production costs or even the foregone agricultural income may represent losses to the region. On the other hand, when these farm costs are considered as net gains to other areas, it may be regarded as compensating benefits. Wage payments made by the irrigation authorities in the operation and maintenance of the project or payments made by the government for extension workers may result as benefits to the region. It is also necessary to consider that if the farmers were using imported inputs like fertilizers, the social opportunity cost of foreign exchange with respect to the whole economy may not be necessarily considered as an opportunity cost to the region. The loss due to the social value of the foreign exchange used is directly concerned with the economy as a whole, and the loss to the region is simply the market cost it pays for the inputs.

In the project region, the indirect benefits which are induced by the primary benefits are, in fact, rather difficult to estimate. Nevertheless, it could be indirectly estimated by checking the flow of agricultural produce when marketed or transferred as raw materials to other production centres. It is already mentioned that the bulk of cotton produced is transferred to a neighbouring textile mill. The mill which is supposed to function two or three production shifts a day could never have been in active operation in the absence of cotton from the region. Therefore, it must be concluded that with direct benefits mentioned earlier and the indirect benefits, the project seems worthwhile.

CHAPTER 9

CONCLUSIONS

An attempt has been made in this study to assess the irrigation project. As we may recall, its construction started in 1961 and although it was planned to be finished by 1965, it was two years behind schedule when it was finally completed in 1967. Such an experience, as those who are directly involved in the implementation of the project well know, is to be experienced time and again.

Regarding costs, the estimated construction cost of the project was 30.4 million Kyats. As it turned out, the total cost amounted to 56.91 million Kyats, i.e. cost overrun of some 87 per cent. As had been established in this study, this was mainly due to a bias towards capital-intensive construction methods.

Coming now to the consideration of benefits, it must be said that it had undoubtedly brought a number of benefits to the project region. Crops, namely rice, long staple cotton, groundnut and sesamum, could now be grown twice a year. The use of sufficient water has accelerated the overall rate of agricultural growth, and agricultural expansion was largely the result of increases in cultivated areas. The relative quantity of land planted to planned crops, especially long staple cotton, rose sharply. Planned crops such as cotton and sesamum now account for over 75 per cent of the cultivated land and nearly 70 per cent of the value of agricultural production.

However, the provincial government's agricultural policies, higher government prices and more free access to water may eventually lure the farmers to push the expansion of cultivated lands and water use to such an extent as to be beyond the technical capability of the dam. In other words, farmers may eventually have to fall back on annual rainfall, river flows and ground water recharge.

If the region were hit by an untimely dry period it would result in a sharp decline in water use. The economic losses and disruption to the region's economy that would result from the sharp decline in water use would be enormous. A substantial portion of investment in crops would never be recovered. Given the importance of the agricultural sector in the region's economy, the investment losses and economic and social disruption would be felt by all sectors of the region.

An emphasis on improving water use efficiency would permit a higher economic growth but require more changes in current water use. The maintenance of the two main canals despite all the year round water flow, wells to reinforce surface water flows, higher farm subsidies and policies leading to efficient water use, are viewed as normal and necessary government actions.

Government investment patterns and policies which might have provided higher agricultural returns were not made, and the search for new irrigation and cultivation methods offering higher returns to water and greater long-term growth potential for the region were discouraged because of their relative neglect in government research efforts and the lack of private economic incentives.

Although further research is needed, sprinkler and drip irrigation systems could be promising new irrigation methods for some crops in the region. Besides these, the government must also be able to supply more key agricultural inputs such as fertilizers, insecticides and farm machinery. It is clear, therefore, that with the aid of the government stable yields cannot be produced to sustain the region's economy.

Although the construction of the project was mainly made out of Soviet credit, the domestic component of the total investment, especially in terms of dedicated manpower, is no less important. In fact, had it not been for the high quality performance of irrigation personnel, the gestation period would have been longer, the project costs greater and net benefits all the lesser for it. But now, due to those people, this study has shown conclusively that the project has really been worthwhile. Finally, in the social benefit-cost analysis, the project, though it was not financially sound, was found to be economically sound from the national standpoint. The results of the social benefit cost analysis proved that only with adjusted market values, the internal rate of return of the project is slightly higher than the ruling official bank rates. With the actual market prices, the economic returns have proved to be very low. Last, but not least, it must be concluded that the project was not intended to achieve high financial returns, but more importantly, was designed to open up a poor region.

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APPENDIX A

Article 1

The government of the Union of Burma Socialist Republic shall ensure the economic and technical assistance to be rendered by the Soviet organizations in the construction in 1962-66 of the Kyet-mauk-taung Irrigation Project by means of executing the designing works, of supplying to the Union of Burma of equipment, machinery and materials which are not available in the Union of Burma and by means of deputing Soviet specialists to the Union of Burma for rendering assistance in the construction, erection, operation and maintenance of equipment.

Article 2

The Revolutionary Government of the Union of Burma shall accomplish through the medium of the Burmese organisations the construction of the Kyet-mauk-taung Irrigation Project provided in Article 1 of the present Protocol, the organization of all construction works including the employment of necessary manpower and the procurement of locally available materials, as well as the construction of access roads and other services required for the implementation and operation of the Kyet-mauk-taung Irrigation Project.

Article 3

For the purpose of furnishing the economic assistance to the Union of Burma in the accomplishment of the Kyet-mauk-taung Irrigation Project, the Government of the Union of Soviet Socialist Republics shall extend to the Revolutionary Government of the Union of Burma, credit up to the amount of 3.5 million roubles (one rouble contains 0.987412 grammes of fine gold) bearing 2.5 per cent interest per annum to make payments for design and surveying work for the Kyet-mauk-taung Irrigation Project to be executed by the Soviet organization, equipment, machinery and materials which are not available in the Union of Burma to be supplied from the USSR to the Union of Burma, f.o.b. Soviet ports; expenses incurred in deputing Soviet specialists to the Union of Burma for rendering technical assistance, excluding cost corrected with their maintenance in the Union of Burma.

In case of a change in the gold parity of the rouble mentioned in the present Article, the amount of the credit in terms of roubles (both utilized and unutilized parts of the credit balance of outstanding principal debt and the interest accrued thereon but not yet paid) shall be adjusted according to the change so as to preserve the gold equivalent of the credit.

Article 4

The Revolutionary Government of the Union of Burma shall repay the credit availed of under Article 3 of the present Protocol during the period of 12 years by equal annual instalments beginning in a year after the Kyet-mauk-taung Irrigation Project has been completed and the reservoir filled with water, but not later than January 1st, 1968.

Interest will accrue from the date of the utilization of a respective part of the credit and shall be paid in the first quarter of the year following the year for which it is accrued; the date of the utilization of the credit to pay for the equipment, machinery and materials shall be the date of the Bill of Lading and for making payments for the design and surveying work, as well as for other kinds of technical assistance there shall be the date of the Invoice.

Article 5

Repayments of the credit and payments of the interest accrued thereon shall be effected by the Revolutionary Government of the Union of Burma by the deliveries of Burmese goods to the USSR under the terms and conditions of the Soviet-Burmese Trade Agreement in force and/or in a freely convertible currency to be agreed upon between the State Bank of the USSR and the Union Bank of Burma.

Three months before the beginning of the year in which repayments of the credit and payments of the interest accrued are due, the parties shall agree for each calendar year on the kinds and prices of goods, and on the quantities and periods for the deliveries thereof.

Should repayments of the credit and payments of the interest accrued be made in a freely convertible currency, the recalculation of the rouble into a freely convertible currency shall be effected on the basis of the gold parity of these currencies on the date of payment.

Article 6

For the purpose of keeping records of the credit used and repaid and payment of the interest accrued thereon, the State Bank of the USSR and the Union Bank of Burma shall open special credit accounts in roubles and shall agree upon the procedure for maintaining the said accounts and transactions under the credit.

Article 7

The Revolutionary Government of the Union of Burma shall reimburse to the Soviet Party expenses connected with the maintenance of Soviet specialists in the Union of Burma to be deputed for rendering technical assistance in the construction of the Kyet-mauk-taung Irrigation Project in accordance with the present Protocol by entering respective amounts in Burmese Kyats to a separate account to be opened with the Union Bank of Burma in favour of the State Bank of the USSR.

The amounts from this account may be used for covering expenses of the Soviet organizations in the Union of Burma.

In case of a change in the gold parity of the Burmese Kyat which at present equals 0.186621 grammes of fine gold, the State Bank of the USSR and the Union Bank of Burma shall make an appropriate revaluation of the balance on the special account indicated in this Article.

Article 8

The Soviet organizations and Burmese organizations duly authorized by the Government of the USSR and the Revolutionary Government of the Union of Burma respectively shall enter into contracts specifying the number of specialists to be deputed as well as volume of deliveries, periods, prices and detailed conditions for executing the designing work, supplies of equipment, machinery and materials, and other obligations of either Party relative to the construction of the Kyet-mauk-taung Irrigation Project provided in Article 7 of the present Protocol.

Article 9

The signing of the present Protocol concerning the economic and technical assistance to be rendered by the Union of Soviet Socialist Republics to the Union of Burma in the construction of the Kyet-mauk-taung Irrigation Project was signed at the State National Theatre, Moscow on 19th February, 1962.

Article 10

Done in duplicate, in Burmese, Russian and English languages, all three texts being equally authentic, at Rangoon, 30th August, 1962.

An arrangement was made between the State Bank of the USSR and the Union Bank of Burma for the maintenance of accounts relating to the extension of credit by the Soviet Government to the Burmese Government under the Protocol of 30th August, 1962. The elements of the arrangement are as follows:

" The Protocol of August 30th, 1962 provides for the grant by the Government of the USSR to the Revolutionary Government of the Union of Burma of a credit to the extent of 3.5 million roubles (one rouble containing 0.987412 grammes of fine gold) bearing an interest of 2.5 per cent per annum for the purpose of rendering economic and technical assistance to the Revolutionary Government of the Union of Burma between 1962 and 1966 in the construction of the Kyet-mauk-taung Irrigation Project.

In accordance with Article 6 of the Protocol, the Union Bank of Burma and the State Bank of the USSR have come to the following understanding, regarding the method of keeping the account in connection with the grant of the abovementioned credit and its repayments:

(1) The Union Bank of Burma and the State Bank of the USSR will open the following accounts in roubles: 'Account No.2/359' for recording the utilization of the credit and its repayment. 'Account No. 4/359' for recording the interest due under the credit and its settlement.

(2) The State Bank of the USSR will, on receipt of invoices presented by the Soviet foreign trade organizations together with the shipping and other documents drawn up in accordance with the contracts concluded between Burmese and Soviet organizations under the Protocol, debit Account No. 2/359 with the value of the invoices.

The Debit Advices under Account No. 2/359 will be sent by the State Bank of the USSR to the Union Bank of Burma, accompanied by the invoices, and the shipping and other documents received from the Soviet foreign trade organizations.

(3) The Union Bank of Burma will, on receipt of the Debit Advices and the accompanying invoices and documents from the State Bank of the USSR, credit Account No. 2/359 with the value of the invoices.

For the value of equipment, machines and materials supplied, the date of credit in Account No. 2/359 will, as stipulated in Article 4 of the Protocol, be the date of the Bill of Lading. For the project prospecting works and other technical services, the date of credit will be the date of the invoice.

(4) On 31st December each year the State Bank of the USSR will compute the interest at 2.5 per cent on the credit extended under Account No. 2/359 and debit the interest to Account No. 4/359.

Upon receipt of the Debit Advice from the State Bank of the USSR, for the interest charged, the Union Bank of Burma will verify the amount shown on the Advice, and credit Account No. 4/359 with the interest due, and confirm the amount to the State Bank of the USSR.

(5) Settlement of interest will be made as provided in Article 4 of the Protocol.

If the settlement is to be made by delivery of goods, by the Union of Burma to the USSR, the Burmese suppliers will present to the Union Bank of Burma the invoices in duplicate together with the Bill of Lading and other documents drawn up in accordance with the contracts concluded between the Burmese suppliers and the Soviet trading organization as provided in Article 5 of the Protocol. The Union Bank of Burma will debit Account No. 4/359 with the value of the invoices and send a copy of the invoices and the accompanying documents to the State Bank of the USSR. The latter will on receipt of the invoices and the accompanying documents, credit Account No. 4/359 with the value of the invoices.

If the settlement is to be in cash, the Union Bank of Burma and the State Bank of the USSR will agree on the type of freely convertible currency that will be employed for the settlement. The Union Bank of Burma will calculate and remit the amount payable in that currency to the Bank designated by the State Bank of the USSR, and advise it by cable of the remittance made and debit Account No. 4/359 with the rouble equivalent.

The State Bank of the USSR will, on receipt of advice from its designated Bank of the remittance by the Union Bank of Burma, credit Account No. 4/359 with the rouble equivalent, and send the Advice of Credit to the Union Bank of Burma. The last payment of interest, either by delivery of goods or by cash as the case may be, will be effected simultaneously with the repayment of the last instalment of the principal amount of the credit.

(6) On the completion of the project, and when the reservoir is filled with water, which must not be later than 1st January, 1968, the representative of the parties which concluded the contract will notify the completion to the State Bank of the USSR, which will draw up a schedule of repayments for the total amount of credit extended. This will be sent to the Union Bank of Burma for confirmation which will check the schedule and confirm its correctness to the State Bank of the USSR.

(7) The repayment of the credit extended will be made in the manner provided in Articles 4 and 5.

(8) If the payment is to be made by delivery of goods, the Burmese suppliers will present to the Union Bank of Burma the invoices in duplicate together with the Bill of Lading and other documents, drawn up in accordance with the contracts concluded between the two parties under Article 5 of the Protocol. The Union Bank of Burma will debit Account No. 2/359 with the value of the invoices and send a copy of these together with the accompanying documents to the State Bank of the USSR. The latter will on receipt of the invoices and the accompanying documents credit Account No. 2/359 with the value of the invoices.

(9) If the repayment is to be made in cash, the Union Bank of Burma and the USSR will agree on the type of freely convertible currency that will be employed for the repayment. The Union Bank of Burma will calculate and remit the amount payable in that currency to the Bank designated by the State Bank of the USSR and advise the State Bank of the USSR by cable of the remittance made and debit Account No. 2/359 with the rouble equivalent. The State Bank of the USSR will on receipt of the advice from its designated Bank of the remittance made by the Union Bank of Burma, credit Account No. 2/359 with the rouble equivalent.

(10) The following dates will be regarded as the date of repayment of the credit:

When making repayment by delivery of goods, the date will be the date of the Bill of Lading. When making repayment by remittance of freely convertible currency, the date will be the date on which funds are received in the accounts of the Bank designated by the State Bank of the USSR. In the case of the repayment of goods by delivery of goods, the invoices will contain the marking that the goods are delivered in repayment of the outstanding credit.

(11) In the event of any alteration of the gold content of the rouble, the balances of Accounts No. 2/359 and No. 4/359 will be revalued. The unutilized credit will also be revalued in the same manner.

(12) Advices under Accounts No. 2/359 and No. 4/359 will be sent by the two Banks, by air mail. On the 1st January and the 1st July every year the State Bank of the USSR will advise the Union Bank of Burma of the balances in Accounts No. 2/359 and No. 4/359 and the Union Bank of Burma will confirm their correctness.

(13) The above accounts are to be operated by the State Bank of the USSR and the Union Bank of Burma free of commission, postage and cable expenses.

(14) The Telegraphic Test Key supplied by the State Bank of USSR will be used for all cable communications between the two Banks. "

The above reveals the full account of the true copy of the Protocol signed between the two countries. After all necessary arrangements were made, a schedule for the repayment of credit was drawn. According to the Protocol, it was agreed that the loan will be evenly disbursed throughout a twelve year period. The annual instalment necessary to pay the interest due at the end of the year and the principal repayment in twelve equal payments are computed by the two governments. The schedule of repayment of credit in accordance with Article 4 of the Protocol was as follows:

Schedule of Repayments

Dates of Payments		Amount of Repayment (in roubles)
1.	1st January, 1968	291,056.56
2.	1st January, 1969	291,056.00
3.	1st January, 1970	291,056.00
4.	1st January, 1971	291,056.00
5.	1st January, 1972	291,056.00
6.	1st January, 1973	291,056.00

Dates of Payments		Amount of Repayment (in roubles)
7.	1st January, 1974	291,056.00
8.	1st January, 1975	291,056.00
9.	1st January, 1976	291,056.00
10.	1st January, 1977	291,056.00
11.	1st January, 1978	291,056.00
12.	1st January, 1979	291,056.00
	Total	3,492,672.56

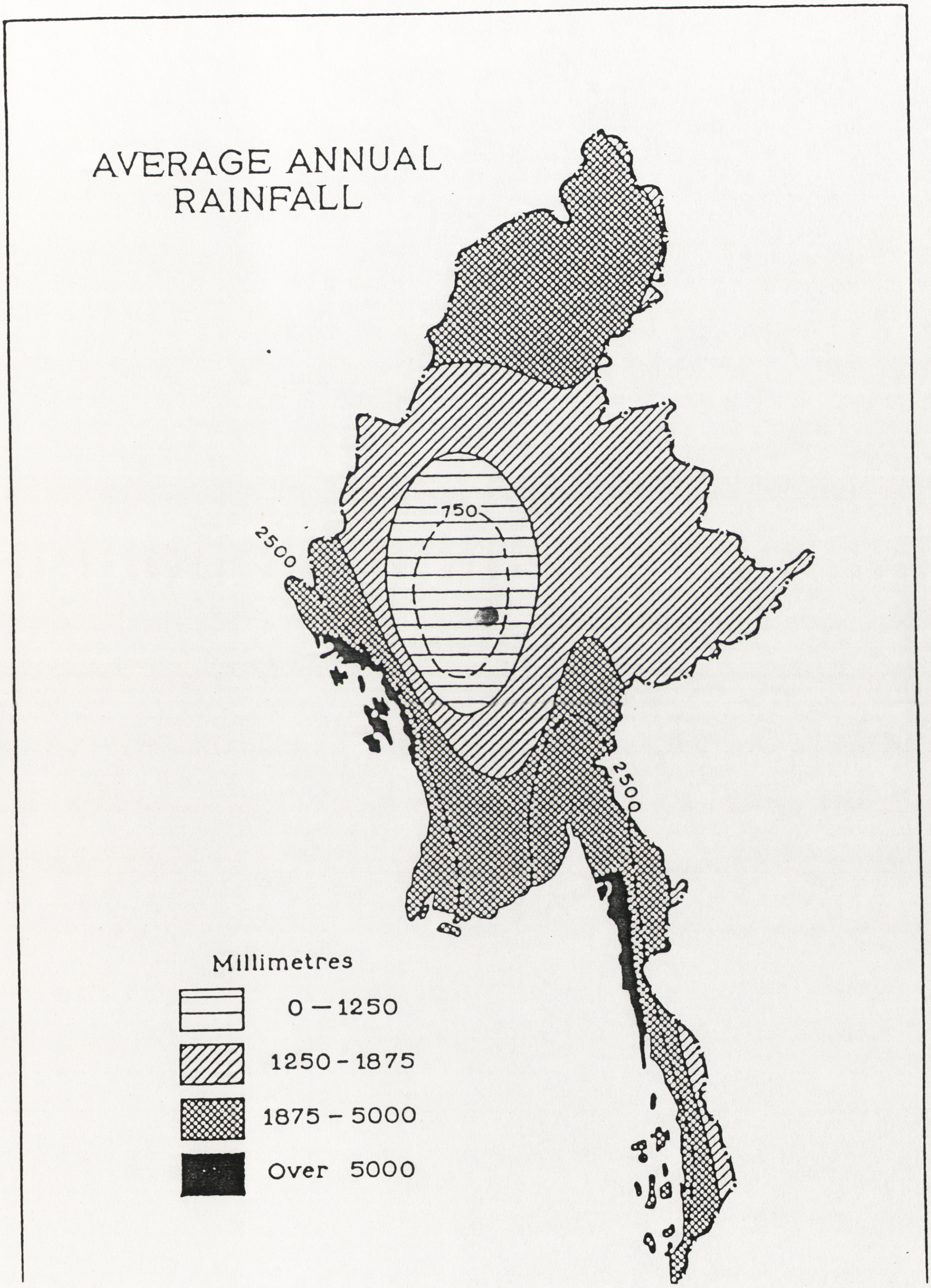
The Burmese Government paid the first interest charges amounting to 7332.36 roubles in the year 1964, three years after the start of the construction of the dam. Interest payments in the following years of 1965, 1966 and 1967, which were still during the years of construction, were 55,936.72 roubles, 77,398.37 roubles and 83,828.66 roubles respectively. It was in 1968, soon after the completion of the project that the repayment of the 'First Instalment of Principal Repayment' was made, together with the interest charges.

The first instalment of principal repayment of roubles 291,056.56 was effected at Chase Manhattan Bank, New York, on the 18th March, 1968. The second instalment was effected at the Bank of England, London, while the third instalment was effected at Westminster Foreign Bank Ltd., London. Obviously, there were yearly changes in the general agreement of the designated bank between the two parties. The following account shows the annual principal repayment with their respective designated banks.

	Principal Repayment	Designated Banks
1.	First instalment of annual payment	Chase Manhattan Bank, New York
2.	Second instalment of annual payment	Bank of England, London
3.	Third instalment of annual payments	Westminster Foreign Bank Ltd., London
4.	Fourth instalment of annual payments	Bank of England, London
5.	Fifth instalment of annual payments	Westminster Foreign Bank Ltd., London
6.	Sixth instalment of annual payments	Federal Reserve Bank of New York, New York
7.	Seventh instalment of annual payments	Girinbank, New York
8.	Eighth instalment of annual payments	Banktrust, New York
9.	Ninth instalment of annual payments	Bank of England, London

	Principal Repayment	Designated Banks
10.	Tenth instalment of annual payments	Bank of England, London
11.	Eleventh instalment of annual payments	Bank of England, London
12.	Twelfth instalment of annual payments	Bank of England, London

Map Showing Average Annual Rainfall and Location of the Kyet-mauk-taung Irrigation Project



Location of the Kyet-mauk-taung Project

APPENDIX A.1

1968-69

First Crop

Crops	Sown Acreage	Matured Acreage	Yield Per Acre Basket/ Viss	Selling Price (Kyat)	Value of Crop Production		Commodities and Services			Labour Cost		
					Value Per Acre	Total Value ('000 Ks.)	Sown Acreage	Cost Per	Total Cost (Kyat)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1. Sesamum	17445	15761	2.16	50	108.00	1702.19	17445	15	261675	17445	35	610575
2. Paddy	-	-	-	-	-	-	-	-	-	-	-	-
3. Groundnut (pyant)	671	671	26.00	6	156.00	104.68	671	15	10065	671	20	13420
4. Groundnut (htaung)	64	64	13.91	6	83.46	5.34	64	15	960	64	20	1280
5. Long staple cotton	2860	940	95.85	1.55	148.57	139.66	2860	35	100100	2860	55	157300
6. Bettle leaf	28	27	1000	5	50000.00	135.00	28	630	17640	28	420	11760
7. Banana	6	6	25	3	75.00	0.45	6	175	1050	6	50	300
8. Short staple cotton	56	52	68.31	1	68.31	3.55	56	7	392	56	30	1680
9. Kyaung-kon groundnut	5494	5494	40.00	6	240.00	1318.56	5494	15	82410	5494	10	54940
	26624	23015				3409.43	26624		477292	26624		851755

Second Crop

Crops	Sown Acreage	Matured Acreage	Yield Per Acre Basket/ Viss	Selling Price (Kyat)	Value of Crop Production		Commodities and Services			Labour Cost		
					Value Per Acre	Total Value ('000 Ks.)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)	Sown Acreage	Cost Per Acre	Total Cost
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1. Groundnut	-	-	-	-	-	-	-	-	-	-	-	-
2. Dried flower	-	-	-	-	-	-	-	-	-	-	-	-
3. Sutani	-	-	-	-	-	-	-	-	-	-	-	-
4. Potato	-	-	-	-	-	-	-	-	-	-	-	-
5. Gram	4	4	6.00	8	48.00	00.19	4	15	60	4	10	40
6.	2	2	4	5	20	00.04	2	7	14	2	10	20
7. Corn	3128	2932	6.00	4	24	70.37	3128	7	21896	3128	10	31280
8. Paddy	631	462	22.7	3	63.81	31.46	631	20	12620	631	40	35240
9. Late sesamum	81	67	3.0	50	150	10.05	81	25	2025	81	45	3645
10. Long staple cotton	-	-	-	-	-	-	-	-	-	-	-	-
11.	10262	9977	6.00	5	30	299.31	10262	5	51310	10262	20	205240
12. Maize	-	-	-	-	-	-	-	-	-	-	-	-
13. Millet	284	269	9640	0.04	385.60	103.73	234	5	1420	284	10	2840
14. Corn seeds & leaves	353	306	25/15	3/4	75/100	26.16	352	5	1760	352	10	3520
15. Pegyi	304	301	5	9.5	47.50	14.30	304	4	1216	304	5	1520
16. Pelone	556	532	5	6	30.00	15.96	556	4	2224	556	10	9560
17. Penauk	1947	1866	3.91	1.50	44.97	83.91	1947	5	9735	1947	10	19470
18. Pe-seenkon	168	168	6.00	6	36	6.05	168	7	1176	168	15	2520
19. Pe-besuk	177	176	3.00	10	30	5.28	177	5	885	177	10	1770
20. Onions	114	114	1516.21	0.90	1364.59	155.56	114	20	2280	114	40	4560
21. Tomato	68	66	1377.89	3	4133.67	272.82	68	12	816	68	10	680
22. Fedder	1449	1375	1000	0.15	150.00	206.25	1449	8	11598	1449	15	21735
23. Butter beans	3	-	-	-	-	-	3	5	15	3	10	30
24. Pe-lonphu	87	73	4.99	6	29.94	2.19	87	5	435	87	10	870
25. Chillies	27	-	-	-	-	-	27	20	540	27	10	270
26. Garlic	5	5	494.44	3	1483.32	7.42	5	20	100	5	40	200
	19649	18695				1336.46	19649		122119	19649		331010
Total	46273	41710				4745.89	46273		599411	46273		1182265

APPENDIX B,1

1969-70

First Crop

Crops	Sown Acreage (1)	Matured Acreage (2)	Yield Per Acre Basket/ Viss (3)	Selling Price (Kyat) (4)	Value of Crop Production: Value Per Acre (5)	Value of Crop Production: Total Value ('000 Ks.) (6)	Commodities and Services: Sown Acreage (7)	Commodities and Services: Cost Per Acre (8)	Commodities and Services: Total Cost (Kyat) (9)	Labour Cost: Sown Acreage (10)	Labour Cost: Cost Per Acre (11)	Labour Cost: Total Cost (Kyat) (12)
1. Sesamum	20861	15379	2.00	2.00	40.00	615.16	20861	15	312915	20861	35	730135
2. Paddy	-	-	-	-	-	-	-	-	-	-	-	-
3. Groundnut (pyant)	5692	5691	36.00	6.00	216.00	1229.26	5692	15	85380	5692	20	113840
4. Groundnut (htaung)	7	7	27.00	7.00	189.00	1.32	7	15	105	7	20	140
5. Long staple cotton	2336	679	55.00	1.55	85.25	57.88	2336	35	81760	2336	55	128480
6. Bettle leaf	22	22	1000.00	3.00	3000.00	66.00	22	930	20460	22	420	9240
7. Banana	1	1	450.00	2.00	900.00	0.90	1	175	175	1	50	50
8. Short staple cotton	38	35	33.00	1.00	33.00	1.16	38	7	266	38	30	1140
9. Kyaung-kon groundnut												
	28957	21814				1971.61	28957		501061			983025

Second Crop

Crops	Sown Acreage	Matured Acreage	Yield Per Acre Basket/ Viss	Selling Price (Kyat)	Value of Crop Production		Commodities and Services			Labour Cost		
					Value Per Acre	Total Value ('000 Ks.)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1. Groundnut	1211	1211	23.25	7	176.61	213.87	1211	15	18165	1211	35	42385
2. Dried flower	-	-	-	-	-	-	-	-	-	-	-	-
3. Sutani	-	-	-	-	-	-	-	-	-	-	-	-
4. Potato	2	2	1000.00	1	1000.00	2.00	2	20	40	2	40	80
5. Gram	9	9	6.00	162	51.60	1.46	9	15	135	9	10	90
6.	-	-	-	-	-	-	-	-	-	-	-	-
7. Corn	2313	2222	5.65	3	16.95	37.66	2313	7	16191	2313	10	23130
8. Paddy	3298	3116	22.78	5	113.90	354.91	3298	20	65960	3298	40	131920
9. Late sesamum	231	224	2.63	25	65.75	14.73	231	25	5775	231	45	10395
10. Long staple cotton	184	154	60.00	1.55	93.00	14.33	104	35	6440	184	55	10120
11.	8492	7708	3.97	3	8.91	68.49	8492	5	42460	8492	20	169840
12. Maize	-	-	-	-	-	-	-	-	-	-	-	-
13. Millet	176	158	7570	0.10	757.00	119.61	176	5	880	176	10	1760
14. Corn seeds & leaves	176	154	$\frac{20}{10}$	$\frac{4}{3}$	$\frac{80}{30}$	$\frac{12.32}{4.62}$	176	5	880	176	10	1760
15. Pe-gyi	271	269	5.00	9.50	47.50	12.78	271	4	1084	271	5	1355
16. Pe-loni	681	619	5.00	9	45.00	27.86	681	4	2724	681	10	6810
17. Pe-nauk	2766	2700	4.00	11.50	46.00	124.20	2766	5	13830	2766	10	27660
18. Pe-seinkon	154	152	5.71	9	51.39	7.81	154	7	1078	154	15	2310
19. Pe-besuk	183	174	3.00	10	30.00	5.22	183	5	915	183	10	1830
20. Onions	125	114	2000	0.65	1300.00	148.20	125	20	2500	125	40	5000
21. Tomato	77	76	1000	1.00	1000.00	76.00	77	12	924	77	10	770
22. Fodder	1091	1065	1000	.10	100.00	106.50	1091	8	8728	1091	15	16365
23. Butter beans	-	-	-	-	-	-	-	-	-	-	-	-
24. Pe-lonphu	40	40	5.00	9.00	45.00	1.80	40	5	200	40	10	400
25. Chillies	10	10	60	2.50	150.00	1.50	10	20	200	10	10	100
26. Garlic	8	-	-	-	-	-	8	20	160	8	40	320
	21498	20177				1354.87	21489		189117	21498		454088
Total	50455	41991				3326.55	50455		690178	50455		1437113

APPENDIX C.1

1970-71

First Crop

Crops	Sown Acreage	Matured Acreage	Yield Per Acre Basket/ Viss	Selling Price (Kyat)	Value of Crop Production		Commodities and Services			Labour Cost		
					Value Per Acre	Total Value ('000 Ks.)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1. Sesamum	18869	18185	3.00	30.00	90.00	1636.65	18869	20	377380	18869	40	754760
2. Paddy	-	-	-	-	-	-	-	-	-	-	-	-
3. Groundnut (pyant)	2075	2075	40.00	7.00	280.00	581.00	2075	20	41500	2075	40	83000
4. Groundnut (htaung)	9	9	20.00	6.00	120.00	1.08	9	20	180	9	40	360
5. Long staple cotton	5579	3996	53.80	1.55	83.39	333.23	5579	35	195260	5579	55	306845
6. Bettle leaf	29	29	1000.00	2.00	2000.00	58.00	29	930	26970	29	420	12180
7. Banana	3	3	450.00	2.00	900.00	2.70	3	175	525	3	50	150
8. Short staple cotton	5	5	55.00	1.00	55.00	0.27	5	7	35	5	10	50
	26569	24302				2612.93	26569		641885	26569		1157345

APPENDIX C.2

1970-71

Second Crop

Crops	Sown Acreage (1)	Matured Acreage (2)	Yield Per Acre Basket/Viss (3)	Selling Price (Kyat) (4)	Value of Crop Production: Value Per Acre (5)	Value of Crop Production: Total Value ('000 Ks.) (6)	Commodities and Services: Sown Acreage (7)	Commodities and Services: Cost Per Acre (8)	Commodities and Services: Total Cost (Kyat) (9)	Labour Cost: Sown Acreage (10)	Labour Cost: Cost Per Acre (11)	Labour Cost: Total Cost (Kyat) (12)
1. Groundnut	6000	5998	40.00	7	280	1679.54	6000	20	120000	6000	40	240000
2. Dried flower	-	-	-	-	-	-	-	-	-	-	-	-
3. Sutani	-	-	-	-	-	-	-	-	-	-	-	-
4. Potato	-	-	-	-	-	-	-	-	-	-	-	-
5. Gram	-	-	-	-	-	-	-	-	-	-	-	-
6.	-	-	-	-	-	-	-	-	-	-	-	-
7. Corn	1203	1145	$\frac{1000}{3}$	$\frac{.15}{3.00}$	$\frac{150}{9}$	$\frac{171.75}{10.30}$	1203	10	12030	1203	15	18045
8. Paddy	4214	4162	34.06	6	102.18	425.27	4212	30	126420	4214	50	210700
9. Late sesamum	419	392	2.00	30	60	23.52	419	25	10475	419	50	20950
10. Long staple cotton	-	-	-	-	-	-	-	-	-	-	-	-
11.	5411	5150	3.00	2	6	30.90	5411	5	27055	5411	20	108220
12. Maize	-	-	-	-	-	-	-	-	-	-	-	-
13. Millet	162	159	1000	0.04	40	6.36	162	5	810	179	10	1620
14. Corn seeds & leaves	179	173	$\frac{20}{3}$	$\frac{4}{3}$	$\frac{80}{9}$	$\frac{13.84}{1.56}$	179	5	895	179	10	1790
15. Pegyi	203	200	4.00	9.50	38	7.60	203	4	812	203	5	1015
16. Pe-loni	756	725	4.00	9	36	26.10	756	4	3024	756	10	36670
17. Pe-nauk	3667	3537	4.00	11.50	46	164.45	3667	5	18335	3667	10	36670
18. Pe-seinkon	142	142	5.00	9.00	45	6.39	142	10	1420	142	15	2130
19. Pe-besuk	61	60	3.00	10.00	30	1.80	61	5	305	61	15	915
20. Onions	-	-	-	-	-	-	-	-	-	-	-	-
21. Tomato	49	46	1000	1.00	1000	46.00	49	12	588	49	10	490
22. Fodder	1423	1409	1000	0.15	150	211.35	1423	8	11384	1423	15	21345
23. Butter beans	18	18	3.00	10.00	30	0.54	18	5	90	18	15	270
24. Pe lonphu	126	115	4.00	9.00	36	4.140	126	5	630	126	15	1890
25. Chillies	1	1	60	3.50	210	0.21	1	25	25	1	15	15
26. Garlic	-	-	-	-	-	-	-	-	-	-	-	-
	24034	23470				2831.62			334298	24034		673625
Total	50603					5444.55			976153			1830970

APPENDIX D.1

1971-72

First Crop

Crops	Sown	Matured Acreage	Yield Per Acre Basket/ Viss	Selling Price (Kyat)	Value of Crop Production		Commodities and Services			Labour Cost		
					Value Per Acre	Total Value ('000 Ks.)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1. Sesamum	14562	11938	2.42	30.00	92.60	866.70	14562	20	291240	14562	40	582480
2. Paddy	-	-	-	-	-	-	-	-	-	-	-	-
3. Groundnut (pyant)	6812	6803	20.00	6.00	120.00	816.36	6812	20	136240	6812	40	272480
4. Groundnut (htaung)	6	6	25.00	7.00	175.00	1.50	6	20	120	6	40	240
5. Long staple cotton	7053	4485	20.36	1.55	31.55	141.50	7053	35	246855	7053	55	287915
6. Bettle leaf	28	28	4000.00	2.00	8000.00	224.00	28	930	26040	28	420	11760
7. Banana	3	3	450.00	2.00	900.00	2.70	3	175	525	3	50	150
8. Short staple cotton												
	28464	23263				2052.36	28464		701020	28464		1245025

APPENDIX D.2 1971-72

Second Crop

Crops	Sown Acreage	Matured Acreage	Yield Per Acre Basket/ Viss	Selling Price (Kyat)	Value of Crop Production		Commodities and Services			Labour Cost		
					Value Per Acre	Total Value ('000 Ks.)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1. Groundnut	-	-	-	-	-	-	-	-	-	-	-	-
2. Dried flower	-	-	-	-	-	-	-	-	-	-	-	-
3. Sutani	1	1	5	8.50	42.50	0.04	1	5	5	1	10	10
4. Potato	1	1	2000	1.00	2000	2.00	1	20	20	1	40	40
5. Gram	-	-	-	-	-	-	-	-	-	-	-	-
6.	-	-	-	-	-	-	-	-	-	-	-	-
7. Corn	-	-	-	-	-	-	-	-	-	-	-	-
8. Paddy	5254	5069	34.18	6	102.54	519.78	5254	30	157620	5234	50	262700
9. Late sesamum	150	148	2.00	30	60.00	8.90	150	25	3750	150	50	7500
10. Long staple cotton	69	62	80.85	1.55	127.52	7.77	69	35	2415	69	55	3795
11.	2553	2424	3.17	3.00	9.51	23.52	2553	5	12765	2553	20	51060
12. Maize	905	905	4.93	2.00	9.86	8.92	905	5	4525	905	10	9050
13. Millet	241	240	9650	0.04	386.00	92.64	241	5	1205	241	10	2410
14. Corn seeds & leaves	137	128	8.00	3	24.00	3.07	137	5	685	137	10	1370
15. Pegyi	221	213	4.00	9	36.00	7.67	221	4	884	221	9	1989
16. Peloni	718	666	3.26	9	29.34	19.54	718	4	2872	718	10	7180
17. Pe-nauk	3217	3009	2.50	10	25.00	75.23	3217	5	16085	3217	10	32170
18. Pe-seinkon	165	165	4.00	9	36.00	5.94	165	10	1650	165	15	2475
19. Pe-besuk	97	95	3.42	10	342.00	32.49	97	5	485	97	15	1455
20. Onions	257	256	1500	2.50	375.00	960.00	257	25	6425	257	40	10280
21. Tomato	100	100	100	1.00	1000	100.00	100	12	1200	100	10	1000
22. Fodder	1539	1513	800	0.15	120	181.56	1539	7	10773	1539	15	23085
23. Butter beans	1	1	5.00	9.50	47.50	0.50	1	5	5	1	15	15
24. Pe-lonphu	163	163	3.26	9.00	29.34	478	163	5	815	163	15	2445
25. Chillies	1	1	58	3.50	203.00	0.20	1	25	25	1	15	15
26. Garlic	-	-	-	-	-	-	-	-	-	-	-	-
	15790	15160				2054.10	15790		224209	15790		420044
Total	44254	38423				4106.10	44254		925229			1665069

APPENDIX E.1

1972-73

First Crop

Crops	Sown Acreage	Matured Acreage	Yield Per Acre Basket/ Viss	Selling Price (Kyat)	Value of Crop Production		Commodities and Services			Labour Cost		
					Value Per Acre	Total Value ('000 Ks.)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1. Sesamum	15475	7326	1.17	30	3.15	259.14	15475	20	309500	15475	90	619000
2. Paddy	-	-	-	-	-	-	-	-	-	-	-	-
3. Groundnut (pyant)	5479	5454	18.00	7	126.00	687.00	5479	20	109580	5479	40	219160
4. Groundnut (htaung)	56	55	20.27	6	121.62	6.69	56	20	1120	56	40	2240
5. Long staple cotton	6121	4917	43.05	1.55	66.7275	328.10	6121	35	214235	6121	55	336655
6. Bettle leaf	31	31	1000.0	2.00	2000.00	62.00	31	930	28830	31	420	13020
7. Banana	3	3	450.00	2.00	900.00	2.70	3	175	525	2	50	150
8. Short staple cotton												
	27165	17786				1343.63	27165		663790	27165		1190225

Second Crop

Crops	Sown Acreage (1)	Matured Acreage (2)	Yield Per Acre Basket/ Viss (3)	Selling Price (Kyat) (4)	Value of Crop Production: Value Per Acre (5)	Value of Crop Production: Total Value ('000 Ks.) (6)	Commodities and Services: Sown Acreage (7)	Commodities and Services: Cost Per Acre (8)	Commodities and Services: Total Cost (Kyat) (9)	Labour Cost: Sown Acreage (10)	Labour Cost: Cost Per Acre (11)	Labour Cost: Total Cost (Kyat) (12)
1. Groundnut	-	-	-	-	-	-	-	-	-	-	-	-
2. Dried flower	-	-	-	-	-	-	-	-	-	-	-	-
3. Sutani	-	-	-	-	-	-	-	-	-	-	-	-
4. Potato	-	-	-	-	-	-	-	-	-	-	-	-
5. Gram	-	-	-	-	-	-	-	-	-	-	-	-
6.	-	-	-	-	-	-	-	-	-	-	-	-
7. Corn	480	1415	2.63	/15	0.8945	0.56	1480	5	7400	1480	20	29600
8. Paddy	4235	3165	20.35	6	121.98	386.07	4285	35	148225	4235	50	211750
9. Late sesamum	107	65	1.57	35	54.95	3.57	107	25	2675	107	50	5350
10. Long staple cotton	2548	575	69.29	3	-	119.5	2548	35	89180	2548	55	140140
11.	3637	3099	2.68	4	10.48	31.2	3657	5	18185	3637	20	72740
12. Maize	-	-	-	-	-	-	-	-	-	-	-	-
13. Millet	314	223	865	/15	129.75	28.93	314	5	1570	314	10	3140
14. Corn seeds & leaves	199	50	$\frac{3.69}{6.66}$	$\frac{6}{4}$	$\frac{21.84}{26.24}$	$\frac{1.09}{1.81}$	199	7	796	199	9	1791
15. Pegyi	240	190	2.02	11/50	23.24	4.41	240	5	700	240	10	2400
16. Peloni	922	478	1.79	10	17.90	8.56	922	4	3688	922	10	9220
17. Pe-nauk	1987	1373	1.14	12/	13.68	18.78	1987	5	9935	1987	10	19870
18. Pe-seinkon	143	143	4.89	10/	43.90	6.28	143	10	1430	143	15	2145
19. Pe-besuk	77	18	1.22	10/	12.20	0.22	77	5	385	77	15	1155
20. Onions	199	199	10000	2/	2000	3980.00	199	25	4975	199	40	7960
21. Tomato	51	40	958	1/50	1477.50	59.10	199	25	4975	199	40	7960
22. Fodder	1269	1162	1000	/25	250.00	290.50	51	12	612	51	10	510
23. Butter beans	-											
24. Pe-lonphu	-											
25. Chillies	-											
26. Garlic	-											
	17408	12145				4943.29			298639			526806
	[illegible]	[illegible]				6286.92			962429			1717030

APPENDIX F.1

1973-74

First Crop

Crops	Sown Acreage	Matured Acreage	Yield Per Acre Basket/ Viss	Selling Price (Kyat)	Value of Crop Production		Commodities and Services			Labour Cost		
					Value Per Acre	Total Value ('000 Ks.)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1. Sesamum	17196	15777	2.75	60.00	165.00	2603.21	17196	20	343920	17196	120	2063520
2. Paddy	-	-	-	-	-	-	-	-	-	-	-	-
3. Groundnut (pyant)	3809	3805	21.00	55.00	1155.00	4394.78	3809	20	76180	3809	60	228540
4. Groundut (htaung)	51	48	12.56	55.00	680.80	83.16	51	20	1020	51	60	3060
5. Long staple cotton	3662	2388	65.28	3.50	228.48	595.61	3662	35	128170	3662	100	366200
6. Bettle leaf	28	28	5000.00	5.00	25000.00	700.00	28	900	25200	28	420	11760
7. Banana	3	3	450.00	3.00	1350.00	4.05	3	175	525	3	50	150
8. Short staple cotton												
	24749	22049				8280.81	24749		575015	24749		2673230

Second Crop

Crops	Sown Acreage (1)	Matured Acreage (2)	Yield Per Acre Basket/ Viss (3)	Selling Price (Kyat) (4)	Value of Crop Production: Value Per Acre (5)	Value of Crop Production: Total Value ('000 Ks.) (6)	Commodities and Services: Sown Acreage (7)	Commodities and Services: Cost Per Acre (8)	Commodities and Services: Total Cost (Kyat) (9)	Labour Cost: Sown Acreage (10)	Labour Cost: Cost Per Acre (11)	Labour Cost: Total Cost (Kyat) (12)
1. Groundnut												
2. Dried flower												
3. Sutani												
4. Potato	2	2	1981.66	2	8963.2	7.93	2	35	70	2	45	90
5. Gram	-	-	-	-	-	-	-	-	-	-	-	-
6.	7	7	2.77	5	13.85	0.10	7	22	154	7	35	245
7. Corn												
8. Paddy	4997	4276	25.49	10	254.40	1087.81	4997	25	124925	4997	50	279850
9. Late sesamum	109	73	2.11	70	147.70	10.78	109	45	4905	109	70	7630
10. Long staple cotton	3034	485	142.19	3/50	49766.50	241.36	3034	5	15176	3034	20	60680
11.	5456	5075	3.00	5	15.00	76.17	5456	5	27280	5456	35	190960
12. Maize	760	258	3.54	4	14.16	3.65	760	5	3800	760	10	7600
13. Millet	62	62	1000	5	5000	310.00	62	7	434	62	9	558
14. Corn seeds & leaves	183	179	10.00 / 3.00	4 / 5	40.00 / 15.00	7.16 / 2.69	183	5	915	183	10	1830
15. Pe-gyi	179	162	3.00	9	27.00	4.37	179	4	716	179	10	1790
16. Pe-lone	114	96	3.05	9	27.45	2.64	114	5	570	114	10	1140
17. Pe-nauk	1568	1215	3.00	12	36.00	43.74	1560	10	15680	1568	15	23520
18. Pe-seinkon	40	40	3.96	10	39.60	1.58	40	5	200	40	15	600
19. Pe-besuk	97	87	3.00	10	30.00	2.61	97	35	3895	97	42	4074
20. Onions	12	12	1439.78	2	2879.55	34.55	12	25	300	12	40	480
21. Tomato	22	20	1045.39	2	2090.78	41.82	22	12	264	22	10	220
22. Fodder	1252	1244	977.18	25	24989.50	310.12	1252	7	8764	1252	15	18780
23. Butter beans	-	-	-	-	-	-	-	-	-	-	-	-
24. Pe-limphu	285	255	3.40	9	30.60	7.80	285	5	1425	285	15	4275
25. Chillies	-	-	-	-	-	-	-	-	-	-	-	-
26. Garlic	-	-	-	-	-	-	-	-	-	-	-	-
	18187	13551				2196.87			209467			574322
Total	42936	35600				10477.70			784482			3247.5

APPENDIX G.1

1974-75

First Crop

Crops	Sown Acreage	Matured Acreage	Yield Per Acre Basket/ Viss	Selling Price (Kyat)	Value of Crop Production		Commodities and Services			Labour Cost		
					Value Per Acre	Total Value ('000 Ks.)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1. Sesamum	13496	1891	1.50	70	105.00	198.56	13496	65	877240	13496	120	1619520
2. Paddy	-	-	-	-	-	-	-	-	-	-	-	-
3. Groundnut (pyant)	3975	3973	20.70	45	931.50	3700.85	3975	155	616125	3975	60	238500
4. Groundnut (htaung)	572	516	15.83	45	712.35	367.57	572	210	120120	572	60	34320
5. Long staple cotton	3865	2453	81.90	3.50	286.65	703.15	3865	205	792325	3865	100	386500
6. Bettle leaf	28	28	5000.00	5	25000.00	700.00	28	900	25200	28	420	11760
7. Banana	3	3	450	3	1350.00	4.05	2	175	525	3	50	150
8. Short staple cotton												
	21939	8864				5674.18	21939		2431535	21939		2290750

APPENDIX G.2 1974-75

Second Crop

Crops	Sown Acreage	Matured Acreage	Yield Per Acre Basket/ Viss	Selling Price (Kyat)	Value of Crop Production		Commodities and Services			Labour Cost		
					Value Per Acre	Total Value ('000 Ks.)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1. Groundnut												
2. Dried flower												
3. Sutani												
4. Potato	10	10	1000	2	2000	20.00	10	35	350	10	45	450
5. Gram	-	-	-	-	15.00	-	-	-	-	-	-	-
6.	7	7	3.00	5	15.00	0.11	7	22	154	7	35	245
7. Corn	-	-	-	-	-	-	-	-	-	-	-	-
8. Paddy	4081	4124	22.50	10	22.5	927.90	4081	80	326480	4681	20	81620
9. Late sesamum	35	19	2.00	70	140	2.66	35	45	1578	35	70	2450
10. Long staple cotton	3703	2091	73.86	350	258.51	540/54.44	3703	205	759115	3703	120	444360
11.	4725	4353	2.98	6	17.88	27.83	4725	22	103950	4725	35	165375
12. Maize	259	249	8.41	5	17.05	4.25	259	22	5698	259	35	9060
13. Milett	130	129	1000	20	2000	258.00	130	25	3250	130	35	4550
14. Corn seeds & leaves	349	346	3.00 / 6.00	5 / 4	15.00 / 24.00	5.19 / 8.30	349	25	8725	349	35	12215
15. Pe-gyi	421	410	3.00	9	27.07	11.07	421	40	16840	421	60	25260
16. Peloni	469	411	2.89	9	26.01	10.89	469	35	16415	469	50	23450
17. Penauk	1428	1237	3.00	10	30.00	37.11	1428	45	64260	1428	40	57120
18. Peseinkon	27	26	4.00	10	40.00	1.04	27	50	1350	27	55	1435
19. Pebesuk	113	104	3.00	10	30.00	3.12	113	35	3955	113	42	4746
20. Onions	71	67	2957.01	2	5194.02	347.9	71	105	7955	71	85	6035
21. Tomato	30	23	1000.00	1	1000	23.00	30	32	960	30	55	1650
22. Fodder	716	716	1000	0.25	2.50	179.0	716	22	15752	716	55	39380
23. Butter beans	-	-	-	-	-	-	-	-	-	-	-	-
24. Pe lonphu	39	22	3.00	9	27	0.59	39	35	1365	39	50	1950
25. Xhilliwa	-	-	-	-	-	-	-	-	-	-	-	-
26. Garlic	-	-	-	-	-	-	-	-	-	-	-	-
	17113	14344				4780.3			1377649			891406
Total	39052	23208				10454.48			3809184			2182156

APPENDIX H.1

1975-76

First Crop

Crops	Sown Acreage	Matured Acreage	Yield Per Acre Basket/ Viss	Selling Price (Kyat)	Value of Crop Production		Commodities and Services			Labour Cost		
					Value Per Acre	Total Value ('000 Ks.)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1. Sesamum	15864	14550	2.90	70	203.00	2953.65	15864	65	1031160	15864	120	1903680
2. Paddy	-	-	-	-	-	-	-	-	-	-	-	-
3. Groundnut (pyant)	4386	4381	8.00	45	360.00	1577.16	4386	155	679880	4386	60	263160
4. Groundnut (htaung)	1388	1371	12.58	45	566.10	676.12	1388	210	291480	1388	60	83280
5. Long staple	3804	2868	90.32	7	632.24	1813.26	3804	205	779320	3804	100	380400
6. Bettle leaf	28	28	5000.00	5	25000.00	700.00	28	900	25200	28	420	11760
7. Banana	3	3	450.00	3	1350.00	4.05	3	175	525	3	50	150
	25473	23201				7724.24	25473		2808015	25473		2642430

APPENDIX H.2

1975-76

Second Crop

Crops	Sown Acreage (1)	Matured Acreage (2)	Yield Per Acre Basket/ Viss (3)	Selling Price (Kyat) (4)	Value of Crop Production: Value Per Acre (5)	Value of Crop Production: Total Value ('000 Ks.) (6)	Commodities and Services: Sown Acreage (7)	Commodities and Services: Cost Per Acre (8)	Commodities and Services: Total Cost (Kyat) (9)	Labour Cost: Sown Acreage (10)	Labour Cost: Cost Per Acre (11)	Labour Cost: Total Cost (Kyat) (12)
1. Groundnut	66	39	9.99	45	449.55	17.53	66	155	10203	66	60	3960
2. Dried flower	-	-	-	-	-	-	-	-	-	-	-	-
3. Suntani	-	-	-	-	-	-	-	-	-	-	-	-
4. Potato	4	4	1418.20	2	2836.40	11.35	4	35	140	4	45	180
5. Gram	-	-	-	-	-	-	-	-	-	-	-	-
6.	-	-	-	-	-	-	-	-	-	-	-	-
7. Corn	-	-	-	-	-	-	-	-	-	-	-	-
8. Paddy	5694	4943	81.79	10	317.90	1571.38	5694	80	45520	5694	120	683280
9. Late sesamum	47	16	2.00	70	140	2.24	47	45	2115	47	70	3290
10. Long staple cotton	3560	724	91.50	7	640.50	463.72	5360	205	729800	3560	120	427200
11.	4762	4521	3.40	20	68.00	307.43	4752	22	104544	4752	35	1666320
12. Maize	197	194	3.92	5	19.60	3.80	197	22	4344	197	35	6895
13. Millet	131	130	92240	/20	1868	242.84	131	25	3275	131	35	4585
14. Corn seeds & leaves	272	127	$\frac{12.00}{4.00}$	$\frac{5}{4}$	$\frac{60.00}{16.00}$	$\frac{7.62}{2.03}$	272	25	6800	272	40	10880
15. Pegyi	317	309	3.14	40	125.60	38.81	317	40	12680	317	60	19020
16. Peloni	424	357	3.51	30	105.30	37.59	424	35	14840	424	50	21100
17. Penauk	1197	1073	2.36	35	82.60	88.63	1197	45	53865	1197	40	47880
18. Pe-seinkon	46	45	3.80	30	114.00	5.13	46	50	2300	46	55	2530
19. Pe-besuk	166	131	3.12	20	63.40	8.17	166	35	5810	166	42	6972
20. Onions	8	8	1490	2	22989	23.84	8	105	840	8	85	600
21. Tomato	36	85	967.41	1	967.41	33.86	36	35	1152	36	55	1980
22. Fodder	927	901	985.42	/25	246.35	221.96	927	22	20394	927	35	32445
23. Butter beans	-	-	-	-	-	-	-	-	-	-	-	-
24. Pe-lonphy	57	56	3.51	30	105.35	5.90	57	35	1995	57	50	2850
25. Chillies	-	-	-	-	-	-	-	-	-	-	-	-
26. Garlic	-	-	-	-	-	-	-	-	-	-	-	-
	17901	13613				3093.82			14306.34			1442147
Total	43374	36814				10818.06			4238649			4084577

APPENDIX I.1

1976-77

First Crop

Crops	Sown Acreage	Matured Acreage	Yield Per Acre Basket/ Viss	Selling Price (Kyat)	Value of Crop Production		Commodities and Services			Labour Cost		
					Value Per Acre	Total Value ('000 Ks.)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1. Sesamum	16482	10940	1.92	70	134.40	1470.34	16432	65	1071330	16482	120	1977840
2. Paddy	-	-	-	-	-	-	-	-	-	-	-	-
3. Groundnut (pyant)	1076	747	9.32	45	419.40	313.29	1076	155	166780	1076	60	64560
4. Groundnut (htaung)	322	307	15.25	45	686.25	210.68	322	210	67620	322	60	19320
5. Long staple cotton	4026	2010	114.80	7	804.09	1616.22	4026	205	825330	4026	100	402600
6. Bettle leaf												
7. Banana												
8. Short staple cotton												
9. Kyaung Kon groundnut	3612	3456	6.50	45	292.50	1010.88	8612	155	559860	3162	60	216720
	25518	17460				4621.41	25518		2690920	25518		2681040

APPENDIX I.2

1976-77

Second Crop

Crops	Sown Acreage	Matured Acreage	Yield Per Acre Basket/ Viss	Selling Price (Kyat)	Value of Crop Production		Commodities and Services			Labour Cost		
					Value Per Acre	Total Value ('000 Ks.)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)	Sown Acreage	Cost Per Acre	Total Cost (Kyat)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1. Groundnut	-	-	-	-	-	-	-	-	-	-	-	-
2. Dried flower	105	87	3.00	40	120	10.44	105	40	4200	105	40	4200
3.	-	-	-	-	-	-	-	-	-	-	-	-
4. Potato	-	-	-	-	-	-	-	-	-	-	-	-
5. Gram	2	1	4.00	65	260	0.26	2	35	70	2	50	100
6.	-	-	-	-	-	-	-	-	-	-	-	-
7. Corn	-	-	-	-	-	-	-	-	-	-	-	-
8. Paddy	4117	2791	44.34	10	443.4	1237.53	4117	80	329360	4117	120	494040
9. Late sesamum	38	23	2.00	80	46	1.06	38	45	1710	38	80	2660
10. Long staple cotton	3561	661	100.26	7	701.82	463.90	3561	205	730005	3561	120	427320
11.	4199	3236	3.00	20	60	194.16	4199	22	92378	4199	35	146965
12. Maize	87	87	4.00	10	40	3.48	87	22	1914	85	35	3045
13. Millet	170	14	9000	0.25	2250	31.50	170	25	4450	178	35	6230
14. Corn seeds & leaves	373	351	8.00 / 4.00	10 / 5	80 / 20	28.08 / 7.02	373	25	9325	373	40	14920
15. Pe-gyi	494	476	3.25	40	130	61.88	494	40	19760	494	60	29640
16. Pe-loni	512	429	2.83	35	94.05	40.35	512	35	17920	512	50	25600
17. Pe-nauk	1182	944	2.03	55	111.65	105.40	1182	35	41370	1102	55	65010
18. Pe-seinkon	22	21	3.00	40	120	2.52	22	50	1100	22	55	1210
19. Pe-besuk	96	75	3.00	20	60	4.50	96	35	3360	96	42	4032
20. Onions	-	-	-	-	-	-	-	-	-	-	-	-
21. Tomato	28	25	1000	2	2000	50.00	28	32	896	28	55	1540
22. Fodder	756	749	1000	0.30	300	224.70	756	22	16632	256	35	26460
23. Butter beans	-	-	-	-	-	-	-	-	-	-	-	-
24. Pe-lonphu	14	11	3.00	35.00	105	1.16	14	35	490	14	50	700
25. Chillies	6	5	57	8.00	456	2.20	6	35	210	6	60	360
26. Garlic	-	-	-	-	-	-	-	-	-	-	-	-
	15770	10286				2470.32	15700		1275150	15770		1254032
Total	41288	27746				7091.73			3966070			1522136